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PARTHENOGENESIS IN COCKROACHES[1]

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Parthenogenesis has been considered rare among cockroaches (Chopard, 1938), but, as Chopard (1948) later pointed out, fewer observations have been made on these insects than on other Orthoptera. However, a number of workers have attempted from time to time to determine whether some of the common, cosmopolitan species of cockroaches can reproduce without fertilization of the eggs. Most of the results have been negative, the writers claiming that either no eggs are deposited by unfertilized females, or if eggs are laid, they fail to develop. Unfortunately, many of these observations were based on small numbers of individuals; the length of the experimental periods were too short; or hatching of eggs was used as a criterion of parthenogenesis; therefore, many facts concerning parthenogenesis in cockroaches were not elucidated. Our survey of the literature shows the following:

Periplaneta americana (L.).—Unmated females either failed to deposit oöthecae or formed small numbers of imperfect or perfect egg cases, the eggs of which failed to hatch (Nigam, 1933; Gould and Deay, 1938; Klein, 1933; Gier, 1947; Pope, 1953).

However, there are four reports which indicate that unfertilized eggs of the American cockroach may develop and hatch. Takahashi (1924) kept seven virgin females of *P. americana* unmated throughout life; each deposited eggs, although the number of oöthecae produced (three per female) was considerably less than from mated females. The oöthecae appeared normal, but most of the eggs did not hatch. The few nymphs that hatched either died during the second or third day or within two months.

Griffiths and Tauber (1942) observed 25 virgin females that produced more than 200 oöthecae; the egg cases were dropped at irregular intervals and were often imperfectly formed. The more nearly normal appearing oöthecae were retained; some of the eggs hatched from capsules from three different females. Four nymphs were reared to maturity and all were females. Griffiths and Tauber concluded that parthenogenesis is a possible but infrequent phenomenon in the American cockroach.

Laing (1946) found that a few oöthecae may be deposited by unfertilized females but these may fail to hatch; however, an average of 14 eggs hatched from 33 out of 58 oöthecae deposited by one unmated female American cockroach.

Haydak (1953), in a study of the effect of various diets on longevity in cockroaches, observed three oöthecae, deposited by virgin female American cockroaches, from which eggs hatched. The viable eggs were deposited when the females were more than 300 days old.

Blattella germanica (L.). Unmated females produced imperfect oöthecae from which eggs failed to hatch (Gerber, 1950). Negative results were also obtained by Gould and Deay (1940). Wille (1920) claimed that copulation is necessary (at 22° C.) for both egg laying and oötheca formation.

Blatta orientalis L. Qadri (1938) stated that unmated females formed oöthecae, but he did not determine whether the eggs developed. Cros (1942) and Lafon (1951) found that virgin females deposited deformed or normal appearing oöthecae, the eggs of which failed to hatch. However, we (1952) observed that virgin females, kept with males from which the left phallic lobe had been removed, deposited oöthecae from which

[1]We thank Albert Levy of our laboratory, and George Riser and Paul Bernhardt, formerly of our laboratory, for their assistance in collecting the data.

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some eggs hatched. We suggested at that time that the eggs which hatched had developed parthenogenetically, because the left phallomere of the male is necessary for successful copulation (Zabinski, 1933).

Supella supellectilium (Serv.). Pope (1953) found that several unmated females produced either apparently normal egg cases from which eggs failed to hatch, or a mass of eggs, not covered by a capsule, which dried up on exposure to air.

Polyphaga saussurei Dohrn. Eggs hatched from a few of a large number of oöthecae obtained from unmated females (Vlasov, 1938).

Pycnoscelus surinamensis (L.). This species was long suspected of being parthenogenetic because of the absence of males in this country (Hebard, 1917). Caudell (1925) and Thomas (1949) observed that unmated females reproduce parthenogenetically; it is now firmly established that in its native habitat (Indo-Malaysia) *P. surinamensis* is bisexual; but in North America and Europe, where it has been introduced, this species is parthenogenetic, producing only females. The chromosome complex of *Pycnoscelus* has been extensively investigated (Matthey, 1942, 1943, 1944, 1948; Suomalainen, 1945).

Blattella (=*Phyllodromia*) *lineata* (Shiraki). One unmated female produced several oöthecae, but none of the eggs hatched (Takahashi, 1924).

For over two years we kept records on the oviposition and hatching of eggs of several species of cockroaches; most of the records extended from the day the adults emerged until they died. Our results, which were briefly mentioned in an earlier paper (Roth and Willis, 1954), show that facultative parthenogenesis in cockroaches may occur more frequently than has been indicated in the literature. In this paper we give a detailed account of this study.

MATERIALS AND METHODS

The unmated female cockroaches were collected daily from rearing containers containing nymphs but no old adults. Although when collected the females were frequently associated with teneral males, we are confident that mating did not occur prior to their separation. We have seen mating between teneral females and older males, but not teneral males, in *Diploptera dytiscoides* (Serv.) (Roth and Willis, 1955) and in *Neostylopyga rhombifolia* (Stoll) (unpublished observation), but never in the following species (subjects of this paper): *Periplaneta americana*, *Blatta orientalis*, *Blattella germanica*, *Supella supellectilium*, and *Nauphoeta cinerea*. Females of these species go through premating periods of various lengths.

The female of *P. americana* is mature and able to reproduce in 1 to 2 weeks after the final molt (Nigam, 1933). Gould and Deay (1940) state of *P. americana* that, "All females undergo a preoviposition period of about 2 weeks and if fertilized start producing capsules at more or less regular intervals." Gupta (1947) states that in none of his observations did male or female American cockroaches copulate earlier than 6 days after becoming adults. Our data show that unfertilized females produced their first oöthecae later than fertilized females; the difference is highly significant.

Males of *B. orientalis* do not copulate until about two weeks after emergence, and the female deposits the first oötheca a few days after copulation (Qadri, 1938). Our unfertilized females of this species produced their first egg cases later than the fertilized females; the difference is highly significant.

The fact that no eggs of *Blattella germanica* or *Supella supellectilium* hatched naturally from oöthecae obtained from virgin females is evidence that there was no copulation between teneral adults prior to isolation.

We conclude that there was very little likelihood of copulation between teneral adults and that the females isolated as virgins were actually unfertilized. Placing males with females does not necessarily assure fertilization. The reproductive performance of some of our supposedly mated females was so like that of unfertilized females that we doubt that those particular females were fertilized. This was true of *P. americana* and especially *B. orientalis*. Changing males had little or no effect on the peformance of those females. However, we retained all such females in the mated series, supplying them with males throughout life, and included their records in the data.

The cockroaches were kept in 250 ml. or larger beakers, individually if unmated, or in pairs if mated. They were fed Purina dog chow checkers and provided with water in cotton-plugged vials. The beakers were covered with cloth tops held in place by rubber bands. During the study, temperatures ranged from 29° C. to 37° C.; the humidity was uncontrolled.

Each female was examined daily except over week ends and holidays. Oöthecae of the oviparous cockroaches were collected when dropped by the females and placed individually in small vials until hatching or until they were examined for egg development. Oöthecae of *Nauphoeta cinerea* (Oliv.) were retained by the females until hatching or until they were prematurely expelled.

As criteria of parthenogenesis we adopted either hatching of the unfertilized egg, or development of the embryo to the pigmented-eye stage. If eggs failed to hatch, the oötheca was dissected and each egg examined for development. Our criterion for development in unhatched eggs was severe, as eye pigmentation occurs late in embryonic development. Undoubtedly the number

of parthenogenetically developed eggs would have been higher had an earlier, less easily determined stage of development been selected. We considered the eggs as hatching if the nymphs managed to escape from the oötheca even though they were not able to free themselves from their embryonic membranes.

EXPERIMENTAL

Periplaneta americana (L.). Initially, series of mated control and virgin females were set up for comparative purposes. Later, as parthenogenetic offspring matured, some of these were set up with or without males. Longevity and egg-laying data for mated and unmated American cockroaches are given in Tables I and II. Unmated females lived longer and produced fewer oöthecae. The percentage of oöthecae with well-developed eggs was high in the unmated series but slightly lower than the mated; the percentage of oöthecae from which eggs hatched was considerably higher in the mated series. There was a marked drop

TABLE I

LONGEVITY, FECUNDITY, AND FERTILITY OF MATED AND UNMATED *Periplaneta americana*

SERIES [a]	NO. ♀♀	MEAN LONGEVITY ± S.E. [b] (days)	MEAN NO. OÖTHECAE PER FEMALE ± S.E. [b]	NUMBER OÖTHECAE		
				RETAINED [c]	WITH DEVELOPED EGGS [d]	FROM WHICH EGGS HATCHED [d]
A	50	311±13.3	67.1± 3.64 [e]	2862 (85%)	2115 (74%)	1720 (60%)
B	112	397±12.7	41.2± 2.35 [f]	3886 (84%)	2587 (67%)	1421 (37%)
C	60 [g]	245±12.7	11.6± 1.92 [h]	551 (79%)	290 (53%)	186 (34%)
D	58	355±14.6	2.5± 0.63 [i]	103 (72%)	19 (18%)	3 (3%)
E	24 [j]	342±11.9	85.2± 2.55	1743 (85%)	1373 (79%)	1175 (67%)
F	4 [k]	406± 9.8	19.8±10.59	71 (90%)	60 (84%)	48 (68%)
F	19 [l]	427± 2.0	16.1± 4.98 [l]	268 (88%)	196 (73%)	141 (53%)
G	17[m]	192±11.8	9.5± 2.64[m]	118 (73%)	53 (45%)	11 (9%)
G	18 [n]	269± 9.3	15.0± 2.77 [n]	206 (76%)	75 (36%)	22 (11%)

[a]A—Mated females, control series. B—Unmated females, parental generation.
C—Mated offspring of series B. D—Unmated offspring of series B.
E—Mated offspring of series C. F—Unmated offspring of series C.
G—Unmated offspring of series D.
[b]S.E. = standard error.
[c]All oöthecae that were not damaged by the insects or in handling.
[d]Percentages based on retained oöthecae.
[e]1 female laid no eggs.
[f]4 females laid no eggs.
[g]1 female accidentally killed when 379 days old.
[h]15 (25%) females laid no eggs.
[i]27 (47%) females laid no eggs.
[j]3 females killed when 413–417 days old, to end experiment.
[k]These females died naturally.
[l]These females were killed to end experiment; 3 laid no eggs.
[m]These females died naturally; 1 laid no eggs.
[n]These females were killed to end experiment; 3 laid no eggs.

TABLE II

EGG PRODUCTION, DEVELOPMENT, AND HATCHING IN MATED AND UNMATED *Periplaneta americana*

SERIES [a]	MEAN NUMBER EGGS			NUMBER OF OÖTHECAE [c]
	PER OÖTHECA ± S.E. [b]	DEVELOPED PER OÖTHECA ± S.E. [b]	HATCHED PER OÖTHECA ± S.E. [b]	
A	14.02±0.040	13.15±0.061	10.78±0.122	2087
B	12.10±0.049	10.12±0.065	4.90±0.095	2531
C	13.65±0.116	11.42±0.254	7.64±0.357	274
D	11.32±0.359	5.68±0.577	0.68±0.412	19
E	14.17±0.052	13.51±0.078	11.65±0.140	1370
F	13.25±0.103	11.67±0.194	7.46±0.325	256
G	12.72±0.195	7.57±0.279	1.96±0.323	121

[a]A—Mated females, control series. B—Unmated females, parental generation. C—Mated offspring of series B. D—Unmated offspring of series B. E—Mated offspring of series C. F—Unmated offspring of series C. G—Unmated offspring of series D.
[b]S.E. = standard error.
[c]Only oöthecae containing developed eggs and in which the eggs could be accurately counted.

in the number of unfertilized eggs which hatched per oötheca, the number being about half that of fertilized eggs.

Although large differences between series are obviously significant, many of the smaller differences also proved to be highly significant. Statistical analyses were made of the differences between the means of the series that logically might be compared. The probabilities that the observed differences occurred by chance are given in Table III.

Forty-nine fertilized females, series A, produced their first oöthecae 13±0.53 days after emergence. Unfertilized females, series B, produced their first oöthecae 25±2.18 days after emergence. The difference is highly significant ($P<.001$).

Parthenogenesis is obviously a successful form of reproduction in this species (series B, D, G), being carried through two filial generations without intervention of fertilization. Comparing second generation parthenotes (series G) with first generation (series D), there is a highly significant increase in the number of oöthecae per female, even though the increase in hatching is not significant. An even more pronounced increase in fecundity occurred in mated second generation offspring (series E), in comparison with mated first generation (series C) offspring of series B unmated females. In addition, the increases in longevity and other egg data (series C *vs.* E) are also highly significant. Surprisingly, the reproductive performance of series E was much better than that of the control series A, the increase in fecundity, egg development, and hatch being highly significant.

The offspring from unfertilized eggs from 295 oöthecae were retained for rearing. For comparative purposes, the young from fertilized eggs from 30 oöthecae were also reared. The results are shown in Table IV. The differences between the means are highly significant ($P<.001$).

TABLE III

VALUES OF *t* AND P FOR DIFFERENCES BETWEEN MEANS, TABLES I AND II

SERIES [a]	LONGEVITY		OÖTHECAE PER FEMALE		EGGS PER OÖTHECA		EGGS DEVELOPED PER OÖTHECA		EGGS HATCHED PER OÖTHECA	
	t	P	*t*	P	*t*	P	*t*	P	*t*	P
A vs. B	4.09	< .001	6.05	< .001	30.38	< .001	33.89	< .001	38.08	< .001
A vs. C	3.58	< .001	14.14	< .001	3.01	< .01	6.63	< .001	8.32	< .001
A vs. D	2.21	< .05	18.78	< .001	6.39	< .001	11.60	< .001	7.93	< .001
A vs. E	1.48	> .1	3.26	< .01	2.28	< .05	3.64	< .001	4.69	< .001
A vs. F	2.00 [b]	> .05	3.57 [b]	< .001	6.94	< .001	7.29	< .001	9.56	< .001
A vs. G	4.99 [b]	< .001	8.93 [b]	< .001	6.53	< .001	19.54	< .001	25.54	< .001
B vs. C	7.71	< .001	8.43	< .001	12.29	< .001	4.96	< .001	7.42	< .001
B vs. D	2.04	< .05	11.71	< .001	1.38	> .1	5.89	< .001	3.83	< .001
B vs. E	1.96	< .05	8.42	< .001	29.03	< .001	33.07	< .001	39.85	< .001
B vs. F	0.13 [b]	> .8	1.70 [b]	> .05	10.06	< .001	7.59	< .001	7.55	< .001
B vs. G	6.20 [b]	< .001	5.16 [b]	< .001	3.08	< .01	8.90	< .001	8.74	< .001
C vs. D	5.71	< .001	4.45	< .001	5.16	< .001	5.88	< .001	5.11	< .001
C vs. E	4.52	< .001	21.41	< .001	4.09	< .001	7.88	< .001	10.46	< .001
C vs. F	3.25 [b]	< .01	1.04 [b]	> .3	2.57	< .02	0.78	> .4	0.37	> .7
D vs. G	5.88 [b]	< .001	3.84 [b]	< .001	2.73	< .01	2.55	< .02	1.54	> .1
E vs. F	2.14 [b]	< .05	8.78 [b]	< .001	7.95	< .001	8.82	< .001	11.83	< .001
F vs. G	8.52 [b]	< .001	1.42 [b]	> .1	2.40	< .02	12.07	< .001	12.00	< .001

[a] A—Mated females, control series. B—Unmated females, parental generation. C—Mated offspring of B. D—Unmated offspring of series B. E—Mated offspring of series C. F—Unmated offspring of series C. G—Unmated offspring of series D.

[b] Comparisons made only with series F and G females that died naturally.

TABLE IV

MATURING OF NYMPHS THAT DEVELOPED FROM FERTILIZED AND UNFERTILIZED EGGS OF *Periplaneta americana*

NYMPHS FROM	MEAN NO. NYMPHS		NO. OÖTHECAE	NO. NYMPHS	
	HATCHED PER OÖTHECA	MATURED PER OÖTHECA		HATCHED	MATURED
Unmated Females	8.3±0.16	2.7±0.12	295	2449	810 [a]
Mated Females	13.3±0.45	10.0±0.54	30	399	301 [b]

[a] All females.

[b] Sex ratio, 1 ♂: 1.09 ♀.

Mortality was high among parthenogenetically developed nymphs, and only 33% of the nymphs matured as compared to 75% of the nymphs hatched from fertilized eggs. Many of the parthenogenetic nymphs were abnormal to some extent, the antennae, legs, or sometimes the abdomen being twisted or malformed (fig. 1). These individuals usually died during the first instar, generally shortly after hatching. Some parthenogenetically developed individuals that managed to escape from the oötheca failed to shed their embryonic membranes. All of the more than 800 adults that developed from unfertilized eggs were females. Although it is possible that some of the nymphs that died were males, it is more likely that parthenogenetic development in *P. americana* is thelytokous.

Blatta orientalis L. Series I and K, Tables V and VI, exemplify parthenogenesis in this species. The unmated females, series I, lived significantly longer than the mated females, series H, but formed fewer oöthecae. Statistical comparisons were made between the means of series H to K; the probabilities that the observed differences occurred by chance are given in Table VII. Although the number of oöthecae produced by unmated females, series I, was not significantly less than the control, the hatch of unfertilized eggs was greatly reduced.

Twenty-eight fertilized females, series H, produced their first oöthecae 13±0.8 days after emergence. Sixty-one unfertilized females, series I, produced their first oöthecae 28±2.3 days after emergence. The difference is highly significant ($P < .001$).

Of the 64 series I females, 5 damaged all the oöthecae they deposited; 42 deposited oöthecae containing some eggs that developed; 17 produced some eggs that hatched.

A mean of 6.7±0.43 nymphs hatched from 49 egg cases. Of the 328 nymphs kept for rearing; 81 (24.7%) matured, 1.65±0.24 per oötheca, all were females.

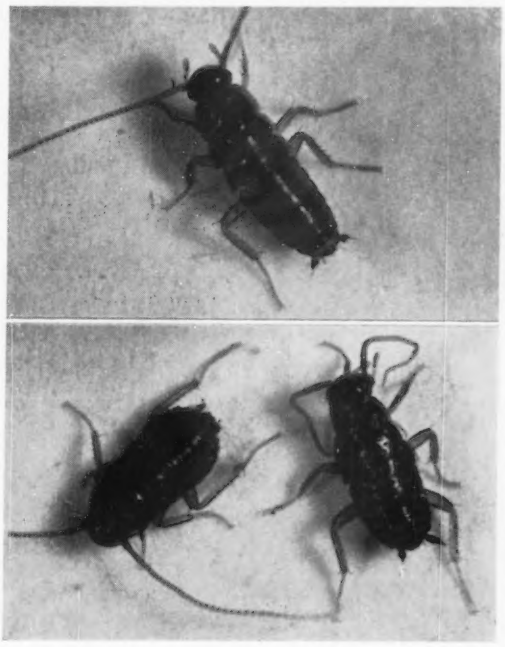

FIG. 1—Recently emerged first instar nymphs of *Periplaneta americana*. Upper, Normal nymph from fertilized egg. Lower, Deformed nymphs from unfertilized eggs.

Blattella germanica (L.), *Supella supellectilium* (Serv.), *Nauphoeta cinerea* (Oliv.). The extent of parthenogenesis in the German, brown-banded, and cinereous cockroaches is given in Tables VIII

TABLE V

LONGEVITY, FECUNDITY, AND FERTILITY OF MATED AND UNMATED *Blatta orientalis*

SERIES [a]	NO. ♀♀	MEAN LONGEVITY ±S.E. [b] (days)	MEAN NO. OÖTHECAE PER FEMALE ±S.E. [b]	NUMBER OÖTHECAE RETAINED [c]	NUMBER OÖTHECAE WITH DEVELOPED EGGS [d]	NUMBER OÖTHECAE FROM WHICH EGGS HATCHED [d]
H	30	113±11.8	11.5±1.70 [e]	336 (97%)	262 (78%)	199 (59%)
I	64	134± 7.0	8.8±0.82 [f]	474 (84%)	272 (57%)	68 (25%)
J	20	86± 8.9	2.2±0.70 [g]	42 (95%)	13 (31%)	10 (24%)
K	34	94± 7.0	0.9±0.42 [h]	21 (70%)	5 (17%)	0

[a] H—Mated females, control series. I—Unmated females, parental generation. J—Mated offspring of series I. K—Unmated offspring of series I.
[b] S.E. = standard error.
[c] All oöthecae that were not damaged by the insects or in handling.
[d] Percentages based on retained oöthecae.
[e] 2 females laid no eggs.
[f] 3 females laid no eggs.
[g] 10 females laid no eggs.
[h] 25 (74%) females laid no eggs.

and IX. Groups of mated controls were not set up because the extremely low rate of hatching of the unfertilized eggs was so obviously different from normal. We already had some information on the reproductive performance of mated individuals of all three species; these data are included (Table IX) for comparison. The differences between the means in Table IX for mated and unmated females are highly significant ($P < .001$).

Twenty-two (39%) unmated females of *Blattella germanica* produced some eggs that developed.

TABLE VI

EGG PRODUCTION, DEVELOPMENT, AND HATCHING IN MATED AND UNMATED *Blatta orientalis*

SERIES [a]	MEAN NO. EGGS			NUMBER OF OÖTHECAE [c]
	PER OÖTHECA ±S. E. [b]	DEVELOPED PER OÖTHECA ±S.E. [b]	HATCHED PER OÖTHECA ±S.E. [b]	
H	14.13±0.142	12.36±0.267	10.62±0.382	249
I	13.09±0.138	8.77±0.242	1.81±0.215	249
J	13.31±0.604	11.69±0.873	8.77±1.561	13
K	13.00±0.405	2.60±0.787	0	5

[a]H—Mated females, control series. I—Unmated females, parental generation. J—Mated offspring of series I. K.—Unmated offspring of series I.
[b]S. E. = standard error.
[c]Only oöthecae containing developed eggs and in which the eggs could be accurately counted.

TABLE VII

VALUES OF *t* AND P FOR DIFFERENCES BETWEEN MEANS, TABLES V AND VI

SERIES [a]	LONGEVITY		OÖTHECAE PER FEMALE		EGGS PER OÖTHECA		EGGS DEVELOPED PER OÖTHECA		EGGS HATCHED PER OÖTHECA	
	t	P	*t*	P	*t*	P	*t*	P	*t*	P
H vs. I	2.60	< .02	1.62	> .1	5.25	< .001	9.96	< .001	20.08	< .001
H vs. J	1.67	> .1	4.30	< .001	0.78	> .4	0.57	> .5	1.09	> .2
H vs. K	1.42	> .1	6.42	< .001	0.67	> .5	5.23	< .001	3.98	< .001
I vs. J	3.56	< .001	5.80	< .001	0.35	> .6	2.70	< .01	6.93	< .001
I vs. K	3.67	< .001	6.81	< .001	0.09	> .9	3.59	< .001	1.19	> .2
J vs. K	0.70	> .4	1.73	> .05	0.30	> .7	6.03	< .001	3.42	< .01

[a]H—Mated females, control series. I—Unmated females, parental generation. J—Mated offspring of series I. K—Unmated offspring of series I.

TABLE VIII

LONGEVITY, FECUNDITY, AND FERTILITY OF UNMATED COCKROACHES

SPECIES	NO. ♀♀ ±S.E. [a]	MEAN LONGEVITY ±S.E. [a] (days)	MEAN NO. OÖTHECAE PER FEMALE ±S. E. [a]	NUMBER OÖTHECAE RETAINED [b]	NUMBER OÖTHECAE WITH DEVELOPED EGGS [c]	NUMBER OÖTHECAE FROM WHICH EGGS HATCHED [c]
Blattella germanica	58	156±5.9 [d]	4.48±0.272	151 (58%)	33 (22%)	0
Nauphoeta cinerea	16	313±3.3 [e]	4.75±0.461	76 (100%)	16 (21%)	13 (17%)
Supella supellectilium	40	142±9.8 [f]	10.53±0.813	387 (92%)	59 (15%)	1 [g]

[a]S. E. = standard error.
[b]All oöthecae that were not damaged by the insects or in handling. With *N. cinerea*, all oöthecae that were retracted into the females' brood sacs and subsequently dropped.
[c]Percentages based on retained oöthecae.
[d]Based on 57 females.
[e]Not true longevity but age of *N. cinerea* when experiment was ended; none had died.
[f]Based on 39 females.
[g]One egg hatched when dissected from an oötheca; none hatched naturally.

TABLE IX

EGG PRODUCTION IN MATED COCKROACHES, AND DEVELOPMENT AND HATCHING IN MATED AND UNMATED COCKROACHES

SPECIES	MEAN NO. EGGS PER OÖTHECA ±S.E. [a]	N [b]	DEVELOPED PER OÖTHECA ±S.E. [a]	N [b]	HATCHED PER OÖTHECA ±S.E. [a]	N [b]
Blattella germanica						
Mated	33.19±0.182	662	29.96±0.662	26	29.92±0.652	26
Unmated	....		3.25±0.546	24	0	24
Nauphoeta cinerea						
Mated	35.19±0.229	354	....		....	
Unmated	....		1.13±0.309	76	0.82±0.246	76
Supella supellectilium						
Mated	15.12±0.090	308	....		15.22±0.425	27
Unmated	....		1.59±0.164	59	1 [c]	59

[a] S. E. = standard error.
[b] N = number of oöthecae.
[c] One egg hatched when dissected from an oötheca; none hatched naturally.

Probably none of the eggs hatched because so few eggs developed per oötheca, there being too few mature embryos to split the keel of the oötheca in order that they might emerge.

Nine (56%) unfertilized females of *Nauphoeta cinerea* produced some eggs that developed parthenogenetically. Eight of these females produced eggs that hatched. It took an average of 235±24.0 days for eight unfertilized females to produce the first nymphs; this was not the time to the first oötheca, however. Seventeen nymphs, developed from unfertilized eggs, were reared to adulthood; all were females. These nymphs matured in 80 to 118 days. The 17 parthenotes were kept unmated, and two gave birth to one and two nymphs, respectively.

Twenty (50%) unfertilized females of *Supella supellectilium* produced one or more oöthecae containing eggs that developed. None of the eggs hatched normally, probably because too few embryos matured in any one oötheca to enable them to split the keel. We succeeded in removing from one egg case a fully developed parthenogenetic embryo; this individual shed its embryonic membrane and survived to become an adult female (figs. 41 to 45 in Roth and Willis, 1954).

Oviposition Rhythm. The rates of oviposition and hatching of eggs during the lifetime of

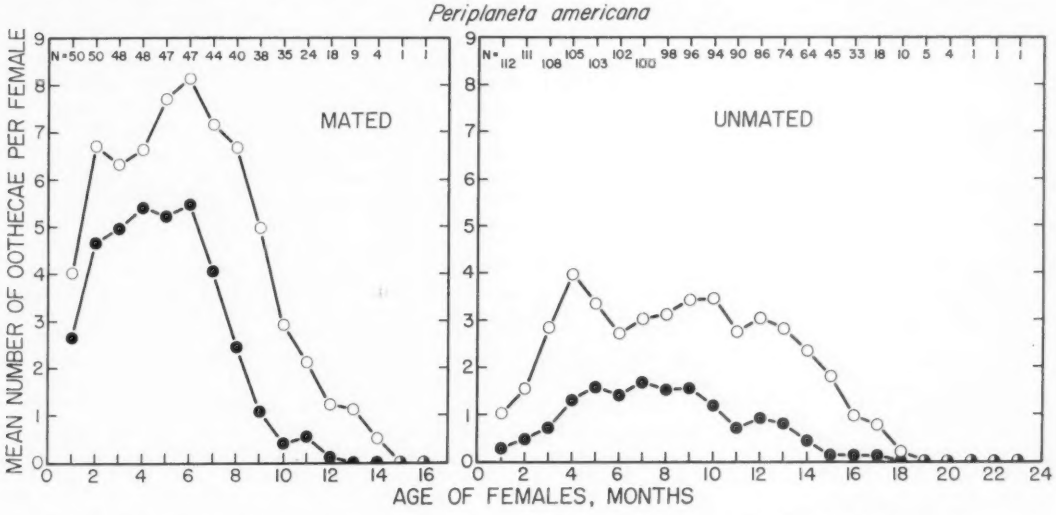
Periplaneta americana
MEAN NUMBER OF OOTHECAE PER FEMALE
N=50 50 48 48 47 47 44 40 38 35 24 18 9 4 1 1
MATED
N= 112 111 108 105 103 102 100 98 96 94 90 86 74 64 45 33 18 10 5 4 1 1 1
UNMATED
AGE OF FEMALES, MONTHS

FIG. 2—Fecundity and fertility during the lifetime of mated and unmated females of *Periplaneta americana*. Open circles = mean number of oöthecae deposited (includes damaged oöthecae). Solid circles = mean number of undamaged oöthecae from which eggs hatched. N = number of females used to obtain the data.

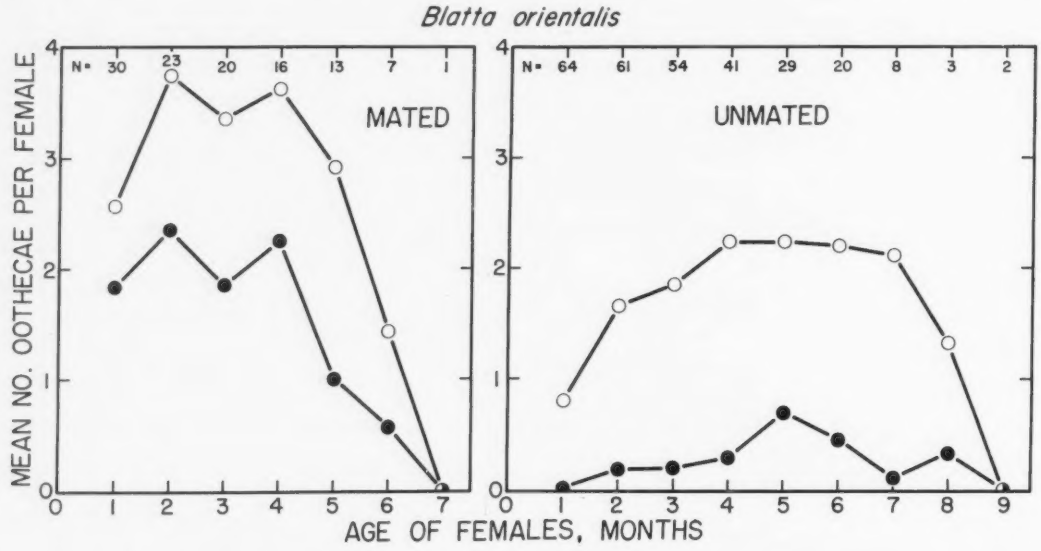

FIG. 3—Fecundity and fertility during the lifetime of mated and unmated females of *Blatta orientalis*. Open circles = mean number of oöthecae deposited (includes damaged oöthecae). Solid circles = mean number of undamaged oöthecae from which eggs hatched. N = number of females used to obtain the data.

mated and unmated American cockroach females are compared in figure 2. The mean number of oöthecae deposited by an unmated female did not reach the highest level attained by the mated females. In both groups the number of oöthecae from which eggs hatched was always lower than the number deposited. In the mated females, the peak of oviposition was reached at about the sixth month and then declined until death. In the unmated females, the peak was reached at the fourth month and then declined more slowly than in the mated females. Cessation of fertility preceded cessation of oviposition by several months in both groups. In laboratory colonies of *Periplaneta australasiae* (Fab.), Pope (1953) found that the last few egg capsules produced by a female, before she died, seldom hatched and usually were smaller than the earlier ones.

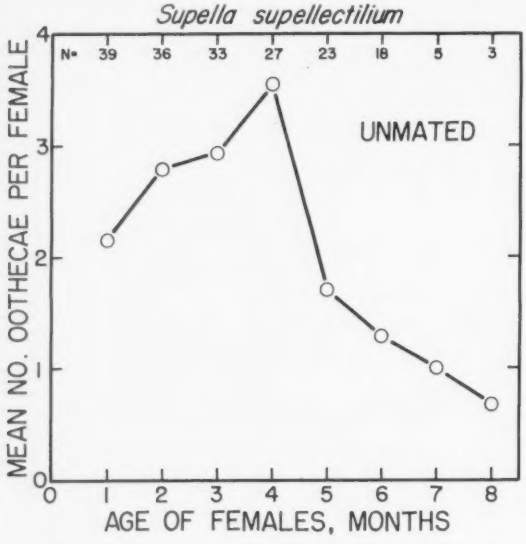

FIG. 4—Fecundity during the lifetime of unmated females of *Supella supellectilium*.

The oviposition and hatching rates of mated and unmated oriental cockroach females are shown in figure 3. The peak of oviposition of mated females was reached in the second month and began to decline sharply after the fifth month. Fertility declined after the fourth month. Fecundity of unmated females reached a peak after 4 months, continued at about the same level until the seventh month, and then declined. Fertility of unmated females was low throughout life, but reached a peak at about the fifth month.

Unmated females of *Supella* also showed a gradual increase in fecundity until the peak was reached at 4 months, after which there was a sharp decline in oviposition (fig. 4).

In *Blattella germanica* 52 of the unmated females produced two or more oöthecae. There were 24.1 ± 0.69 days between the depositions of successive egg cases (min. = 6 days; max. = 60 days).

DISCUSSION

There is a marked difference between our results and those reported in the literature concerning parthenogenesis in cockroaches. The extent of parthenogenesis reported by other workers is considerably less than we have found in the present work. This discrepancy may be attributed to the reasons given in our introduction, or perhaps temperature may affect the degree of parthenogenesis; in general, our female cockroaches were kept at higher temperatures than those of other workers. A temperature effect is indicated by the greater rate of fecundity of *P. americana* found in the present work, as compared to other studies (cf. Griffiths and Tauber, 1942).

It is apparent that parthenogenesis can occur rather frequently in *P. americana*. In this species parthenogenesis has been carried through two filial generations; however, the percentage of parthenogenetic individuals that matured was less than the proportion of individuals that developed from fertilized eggs. Though the hatching of eggs from the first generation of parthenotes was considerably lower than that from mated females (a drop in hatching of eggs from 60% to 3% of the oötheca), there was some indication of an increase in hatch of eggs from the second generation of parthenotes (eggs in 9% to 11% of the oöthecae hatched). There is a suggestion of genetic selection in the increase in reproductive capacity in the F_2 generations that descend from the original unmated females.

From all the data at hand, parthenogenesis in cockroaches is thelytokous. In our experiments all parthenotes that matured were females, in *P. americana*, *B. orientalis*, *N. cinerea*, and *S. supellectilium*. Only female parthenotes have been reported in the literature, in *P. americana* (Griffiths and Tauber, 1942) and in *Pycnoscelus surinamensis* (Caudell, 1925; Thomas, 1949; and others). Thelytokous parthenogenesis also occurs in the desert locust, *Schistocerca gregaria* Forsk, and has been reported for many other Acrididae as well (Hamilton, 1953).

SUMMARY

All of the following five species of cockroaches investigated in this study have been found to exhibit some degree of parthenogenesis: *Periplaneta americana*, *Blatta orientalis*, *Nauphoeta cinerea*, *Blattella germanica*, and *Supella supellectilium*. Unfertilized eggs of *Periplaneta*, *Blatta*, and *Nauphoeta* may hatch, whereas those of *Blattella* and *Supella*, though capable of completing development, are unable to hatch from the oötheca. Parthenogenetic development was carried through two filial generations in *P. americana*. Parthenogenesis in cockroaches is thelyotokous.

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A NEW SUPERFAMILY OF TROMBIDIFORM MITES WITH THE DESCRIPTION OF A NEW FAMILY, GENUS, AND SPECIES (Acarina: Iolinoidea: Iolinidae: Iolina nana) [1]

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Mites constitute a large group of animals that is relatively unknown, and it is not unusual to encounter forms that are representatives of previously unknown higher taxonomic categories. The mites on which this new superfamily is based are parasitic on tropical cockroaches. Their morphology indicates that they are somewhat intermediate between the predaceous raphignathoids and the phytophagous tetranychoids.

The specimens were submitted through the courtesy of L. M. Roth, Research and Development Laboratories, Philadelphia Quartermaster Depot, U. S. Army. The illustrations were prepared by E. W. Baker, Division of Insect Detection and Identification, U. S. Department of Agriculture.

Iolinoidea, new superfamily

Although related to the Raphignathoidea Grandjean, 1944, these mites are distinct in having a simple, single segmented palpus and in having a simple, transverse female genital opening more nearly like that found in the Tetranychoidea Reck, 1952. There are no dorsal scutal sensory areas on the propodosoma, although a pair of long slender sensory setae arise from pitlike bases. The cheliceral stylets are long, whiplike, and recurved proximally in their fused bases, somewhat similar to those found in the Tetranychoidea (in general the chelicerae of the Raphignathoidea are much shorter although of the same general pattern). Tarsus I does not possess claws nor empodium, while tarsi II, III, and IV possess long claws and slender, rayed empodia similar to those of the Raphignathoidea.

[1]Accepted for publication, May 17, 1955.

Iolinidae, new family

With the characters of the genus. It is possible that the lack of appendages on tarsus I, the strongly reduced palpi, the development of the peritremes, and the setation on the dorsum of the idiosoma are characters of family significance.

Iolina, new genus

Type.—*Iolina nana*, new species.

Gnathosoma plainly visible from above; basal segments of chelicerae fused, the fixed chelae degenerate, the movable chelae long, whiplike, recurved proximally; freshly mounted specimens with a pair of grooves running from the lateral margins of the chelicerae inward to the fused posterior inner portions of the chelicerae, possibly representing a primitive or simple type of external peritreme (in specimens long mounted this groove is not apparent because of expansion of the mite); palpus very simple, consisting of a single elongate segment bearing a distal and a predistal seta; venter of gnathosoma with three pairs of setae. Tarsus I without pretarsus, claws, or empodium; tarsi II, III, and IV with pretarsi, claws, and sparsely rayed empodia; tarsus I dorsally with a slender, long, striate, rodlike sensory seta and two tactile setae proximally; ventrally with a pair of distal setae paired with short setae similar to the duplex setae of the Tetranychidae; tibia I with a short bifurcate sensory seta and three tactile setae. Body in specimens not flattened by mounting with a distinct marginal indentation between propodosoma and hysterosoma and with a distinct indentation laterally on the hysterosoma between

coxae III and IV; dorsal integument with numerous dotted striae. Propodosomal dorsum with four pairs of setae and two tiny sensory pegs; hysterosomal dorsum with four pairs of dorsocentral setae and a pair of setae laterad of first and fourth pairs of dorsocentrals, the caudal margin with three pairs of setae. Podosoma ventrally with three pairs of medioventrals. Female opisthosoma with four pairs of pregenital setae and two pairs of para-anals; genital opening a simple, transverse slit; anus separate and located near caudal margin. Male opisthosoma with two pairs of setae anteroventrally and with four pairs of genito-anal setae; intromittant organ a pair of slender genital stylets.

Iolina nana, new species

Female.—First and third dorsal propodosomals, dorsocentral hysterosomals, and first lateral hysterosomals rather short, somewhat broadened proximally, attenuate, nude; second dorsal propodosomals very fine and long; second lateral hysterosomals and first two pairs of caudal setae long, setiform; last pair of caudal setae short, setiform. Length of recently emerged female 176 μ, including gnathosoma 206 μ; width 106 μ. Length of more mature female 233 μ, including gnathosoma 266 μ; width 100 μ.

Male.—Similar to female but smaller and narrower, especially posteriorly, and the first pair of lateral hysterosomals long and setiform. Length of body 150 μ, including gnathosoma 172 μ; width 100 μ.

Nymphs.—Protonymph and deutonymph each having a transverse suture across anterior portion of propodosoma, and lacking genital opening, but otherwise similar to female.

Larva.—Six legged but otherwise similar to nymphs.

Holotype.—Female, Cambridge, Massachusetts, March 19, 1953 (L. M. Roth), on *Blaberus craniifer;* in the U. S. National Museum.

Paratypes.—Seven females, 2 males, 8 nymphs, 1 larva, Cambridge, Massachusetts, March 19, 1953 (L. M. Roth), *Blaberus craniifer;* 62 females, 17 males, 46 nymphs, 2 larvae, Philadelphia, Pennsylvania, March 4 and April 8, 1953 (L. M. Roth), on *Blaberus craniifer.*

Also studied were five nymphs and one male, Philadelphia, Pennsylvania (from Hawaii), May 6, 1954 (L. M. Roth), on *Diplotera dytiscoides.*

The mites were found attached near the wing bases of the cockroaches.

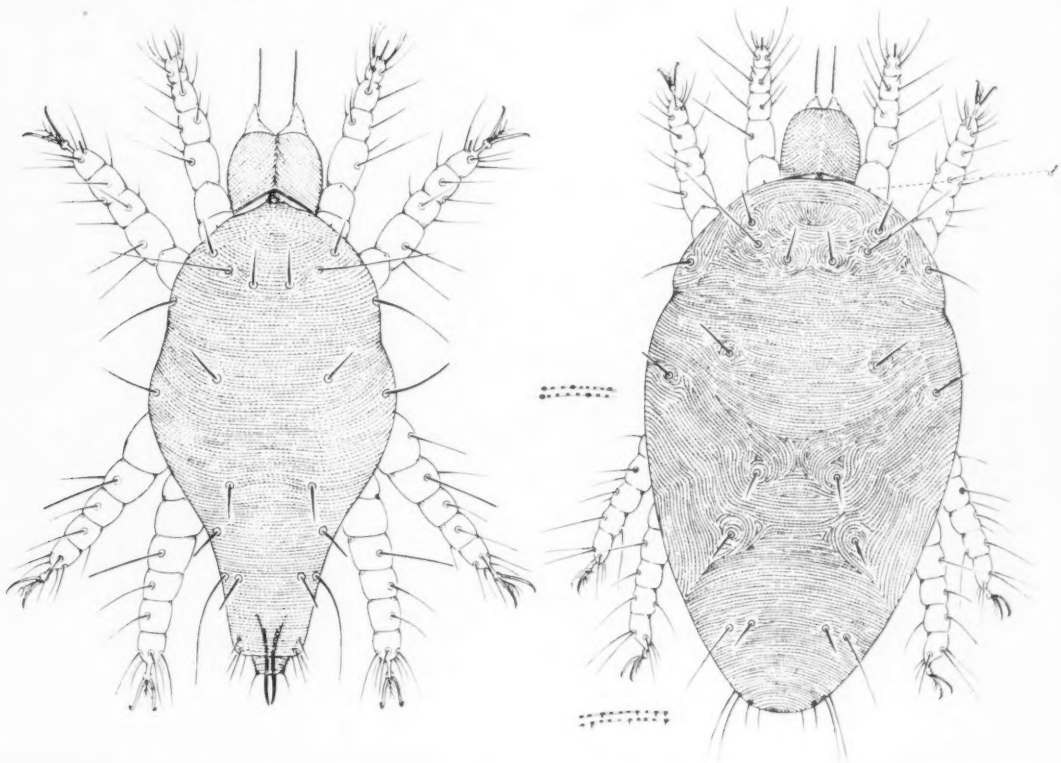

FIG. 1. Dorsal aspect of male (left) and female (right), with enlargement of stria as seen dorsally (above) and laterally (below).

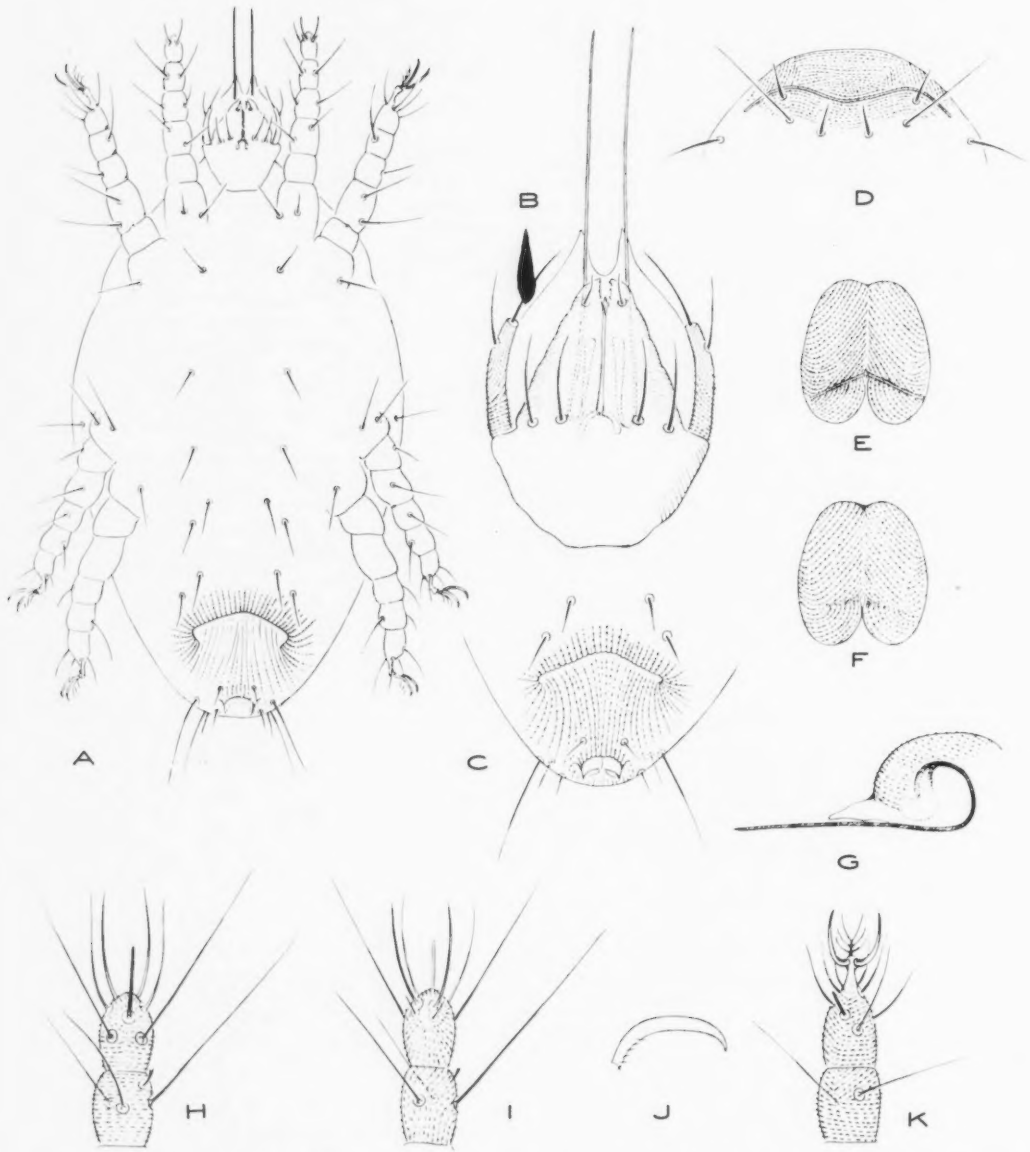

FIG. 2. A, Ventral aspect of female; B, ventral aspect of gnathosoma of female; C, details of genito-anal region of female; D, anterodorsal area of propodosoma of nymph; E, stylophore of fresh mount; F, stylophore old mount; G, lateral aspect of gnathosoma of larva; H, of dorsum of tibia and tarsus I of female; I, venter of tibia and tarsus I of female; J, claw, K. dorsum of tarsus II of female.

THE NEARCTIC COMPONENTS OF THE TRIBE ACANTHOCININI (COLEOPTERA: CERAMBYCIDAE). PART II

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Hirsutographis Dillon, gen. nov.

Small, convex, elongate-ovate forms. Head impunctate, on vertex scarcely impressed behind antennal tubercles; front nearly as high as wide, slightly narrowed between and below eyes, convex, the mouthparts placed at a distinct angle to front; eye with lower lobe oblong, erect, one-half again as tall as gena, isthmus broad, scarcely narrower than upper lobe, which is nearly as broad as interocular space; antennal tubercles moderately prominent, strongly divergent. Pronotum about one-half again as wide across lateral tubercles as long, sides irregular, scarcely narrower at base; lateral tubercles feebly elevated, armed at basal two-fifths with a short tooth; disk atuberculate, convex, subtumid, impunctate except in basal sulcus, which is rather distinctly interrupted at side by lateral tubercle. Elytra strongly convex; basal gibbosity feeble; disk sparsely, simply punctate, and with many, long, erect hairs, without costae; apices truncate or emarginate, the outer angle strongly dentate; humeri rounded. Prosternal process a little less than half as broad as a procoxal cavity; mesosternal process two-thirds as broad as a mesocoxal cavity. Fifth sternite in female as long as third and fourth together. Legs of moderate length, hind ones successively a little longer; femora clavate, robust, metafemora (in female) distinctly more slender than mesofemora, reaching to middle of fourth sternite; metatarsi with first segment subequal to next two together; tibiae with a number of short, suberect hairs. Antennae one and two-thirds times as long as body in female, sparsely fimbriate beneath nearly to apex and irregularly, sparsely hirsute above, especially on apices of segments; scape nearly attaining base of pronotum; third segment equal to first; rest gradually shorter, except eleventh, which is subequal to tenth (female).

Genotype: Hirsulographis pulchra Dillon, spec. nov.

Remarks: While this genus is most closely related to *Graphisurus*, which it resembles in the form and sculpturing of the pronotum and in having long, erect setae on the elytra, it differs in having the prosternum nearly half as broad as a procoxal cavity, in the elytral apices externally produced into a long tooth, and in having the "ovipositor" not elongate.

Hirsutographis pulchra Dillon, spec. nov.

Female: Dark chestnut brown, rather densely covered with longish fulvous pubescence and maculate with shorter and sparser fuscous pubescence. Head above with a large, triangular, fuscous macula each side of middle. Pronotum with a brown-fuscous vitta each side of middle, narrowly coalescent at apex, and with a similar, but slightly narrower vitta on deflexed sides; a fine fuscous vitta on basal three-fifths of median line, not attaining base, and above lateral tubercle a rather narrow one, which often recurves to form a J-shaped marking. Scutellum with basal angles fuscous. Elytra largely fuscous pubescent, the fulvous reduced to three macular fasciae and an apical macula, the fasciae arranged as follows: first oblique, extending from side below humerus to suture at basal third, the second transverse, at middle, and third at apical fourth, undulating. Body beneath and legs sparsely ashy pubescent; metasternum posteriorly on each side and meso- and metasternal side-pieces maculate with fulvous; first to fourth abdominal sternites laterally at apex fringed with fulvous hairs and each side with a small, fulvous macula; femora with an indistinct fuscous macula before apex; tibiae and tarsi fuscous pubescent, the former with a broad ashy annulus before middle. Antennae fuscous pubescent, first to fourth segments indistinctly ashy annulate at base.

Head scarcely impressed behind antennal tubercles, impunctate; front very nearly as high as wide, narrowed between and below eyes, broadly convex; eyes with lower lobe one-half again as tall as gena, oblong, erect, upper lobe only slightly wider than the broad isthmus and nearly as broad as upper interocular space. Pronotum about one-half again as broad across lateral tubercles as long, sides somewhat narrowed basally; lateral tubercles feebly elevated, placed at basal two-fifths, armed with a small tooth; basal sulcus distinct, provided with a row of very coarse punctures, somewhat interrupted at side by the lateral tubercle; disk impunctate and without tubercles, evenly convex. Elytra with a number of coarse, sparsely placed punctures, many of which bear long, erect, black setae, the punctures extremely sparse apically; apices squarely truncate or emarginate, the outer angle produced into a robust tooth. Antennae

two-thirds again as long as body, beneath with widely spaced, rather long fringing hairs to seventh or eighth segments, rest of surface sprinkled with short or rather long, suberect hairs, especially toward apex of each segment; first segment reaching nearly to base of pronotum; third segment equal to first; rest gradually decreasing in length, except eleventh which is subequal to tenth.

Length, 6.5–6.9 mm.; width, 2.4–2.5 mm.

Holotype: Female; South Miami, Florida, June 2, 1952. (D. G. Kissinger) [author's collection].

Paratype: Female; same data as type; [DGK].

Remarks: While this species recalls *Lepturges cubaecola* Fisher in its maculation, especially in that of the pronotum and in the hirsute elytra, it apparently is in no way related to it. In the first place, the prosternal process is quite broad, being very nearly one-half as broad as a procoxal cavity, and in the second place, the elytral apices have the outer angle produced into a strong tooth.

The author is grateful to Mr. David G. Kissinger for his generosity in permitting him to retain the type of this fine species in his collection.

Sternidius LeConte

Amniscus Haldeman, 1847, Trans. Amer. Philos. Soc. (2) 10: 46 [ex parte].

Liopus Serville. LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia (2)2: 170 [ex parte]. Horn, 1880, Trans. Amer. Ent. Soc. 8: 123. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 121. Blatchley, 1910, Col. Ind. p. 1073. [misdet.]

Leiopus Serville. Casey, 1913, Mem. Col. IV, p. 310. Knull, 1946, Bull. Ohio Biol. Surv. 39: 248. [misdet.]

Sternidius LeConte, 1873, Smiths. Misc. Coll. 264, p. 234.

Eleothinus Bates. Bates, 1885, Biol. Centr.-Amer. Col. V, p. 392. [misdet?]

Usually small, subdepressed, elongate-oblong forms but *wiltii* is moderately small, subcylindrical, and elongate-ovate. Head with a few setigerous punctures especially near eye, otherwise virtually impunctate; vertex arcuately declivous, more or less impressed medially behind lateral tubercles; front convex, in many species strongly so, in profile continuing the arc of the vertex, so that the head appears partially spherical, front transverse, at least feebly, sometimes as much as one-third again as wide as high, somewhat narrowed between and below eyes; eyes with lower lobe variable in shape from oblong and erect through quadrate to distinctly transverse, at least as tall as gena, usually up to one-third again as tall, in *floridanus* twice height of gena, isthmus as a rule three or four rows of facets wide, upper lobe arcuate, from a little less than half to three-fifths as wide as upper interocular space. Pronotum ranging from one-half to three-fourths again as wide across lateral tubercles as long, sides more or less tapering to apex, strongly constricted at base; lateral tubercles small but distinct, placed near basal third, armed with a short tooth, and not interrupting basal sulcus which is broad and not sharply defined, apical sulcus wanting; disk with three low tubercles placed in an inverted triangle at middle, entire surface densely punctate, punctures in a few species partially concealed by pubescence. Elytra densely punctate to apex, each with four costae which vary in prominence in the several species, provided with small, scarcely elevated, sometimes tufted tubercles; basal gibbosity small, slightly prominent, occasionally subobsolete; apices somewhat attenuate, obliquely truncate or narrowly emarginate at suture, the angles not or feebly prominent. Prosternal process usually quite narrow, about one-sixth as wide as a procoxal cavity, but sometimes wider (in *fascicularis* one-fifth, in *moderator* one-fourth, and in *crassulus* one-third as wide as a procoxal cavity); mesosternal process anteriorly partially covering mesocoxae, strongly tapering, the extreme apex flared each side, apex more or less broadly emarginate, at narrowest point ranging from two-fifths (*alpha*, *suturalis*, and *vittatus*) through one-half (*wiltii*, *mimeticus*, and *imitans*) to or nearly to three-fifths (in remaining species) as wide as a mesocoxal cavity. Fifth sternite in male as long as fourth, in female equal to third and fourth combined. Legs posteriorly successively longer; metafemora somewhat less clavate than mesofemora, especially in female, in which sex they usually attain apex of fourth sternite, while in the male they often reach to tip of abdomen; mesotarsi with first segment typically as long as next two together, but in *mimeticus* and allies slightly shorter, metatarsi with first segment usually one-sixth longer than next two combined, but (in the same exceptional group) just equal in length to these two. Antennae ranging from one and one-third to nearly two times as long as body, subequal in length in the sexes, without fimbriation beneath or virtually so; scape reaching beyond middle of pronotum, sometimes to basal third; third segment varying in the several species from slightly shorter than first to one-fourth again as long as it; fourth subequal to or shorter than third; rest, including eleventh, gradually decreasing in length.

Genotype: *Lamia alpha* Say, herewith designated.

Remarks: The very narrow prosternal process (with some exceptions) and the comparatively broad mesosternal process, combined with the feebly trituberculate and entirely densely punctate pronotal disk and convex front are perhaps the most reliable diagnostic characters of this highly plastic genus. In addition the metatarsi have the first segment as long or slightly longer than the next two together and the pronotum lacks an apical transverse sulcus, while the basal one is broad, poorly defined, but entire, forming a deep constriction behind the lateral tubercles.

While this genus is somewhat related to the Old World *Leiopus*, with which it has been confused for the past century, it is quite distinct

from it. In *Leiopus* the front is only feebly convex, with the mouthparts placed nearly in the same plane, the lower ocular lobe is distinctly shorter than the gena, the upper lobe only one-third as broad as interocular space, and the mesosternal process is but one-third as broad as a mesocoxal cavity. Moreover, the pronotum (in addition to a different discal sculpturing) when viewed from the side has its anterior margin parallel to the basal, whereas in *Sternidius* the apical margin strongly tapers to the procoxae.

KEY TO SPECIES

1. Antennae with fourth segment distinctly longer than first; pronotal punctation distinct..... 2
   Antennae with fourth segment subequal to or shorter than first; pronotal punctation usually largely concealed by pubescence..... 8
2. Elytra with a distinct, fine, fuscous vitta along suture on basal half..... 3
   Elytra without a vitta along suture..... 4
3. Eye with lower lobe oblong, erect; elytra on basal half of deflexed sides with a prominent fuscous vitta..... **suturalis**
   Eye with lower lobe transverse; elytra not vittate on sides..... **vittatis**
4. Eye with lower lobe erect, twice as tall as gena, upper lobe three-fifths as wide as upper interocular space; front scarcely transverse; Florida..... **floridanus**
   Eye with lower lobe often transverse, not more than one and one-half times as tall as gena, upper lobe usually one-half or less as broad as interocular space; front one-fourth wider than high (or, if only feebly transverse, Western species)..... 5
5. Front one-tenth or less again as wide as high; entire body covered with bright ashy pubescence, with which the pronotal and elytral fuscous maculae contrast sharply; Western forms 6
   Front about one-fourth again as wide as high; pubescence generally dull in color, maculation not sharply contrasting as a rule, but some ashy pubescent, fuscous maculate forms do occur; Eastern and Western Forms..... 7
6. Elytra with basal lateral fuscous macula not attaining side margins, scarcely larger than the rounded post-median sutural spot of the same color; West Texas..... **imitans**
   Elytra with basal lateral fuscous macula extending one-fourth of elytral length along side margin, large, much more extensive than post-median sutural marking, which is fasciiform, oblique; Arizona..... **centralis**
7. Antennae with second segment about twice as long as wide at apex; elytra behind middle with an undulating transverse white fascia, not followed posteriorly by a distinct fuscous band..... **fascicularis**
   Antennae with second segment about one-fourth again as long as wide at apex; elytra very variable, but never with a transverse white fascia, often with an oblique one, which is outlined behind by a fuscous band, placed at an angle of at most 65° with suture..... **alpha**
8. Front feebly wider than high; pronotal disk strongly, irregularly mottled with fuscous; elytra with sides rounded, on disk behind middle an indistinct whitish fascia outlined posteriorly with fuscous, placed transversely although often ascending at suture; length 7–9 mm.; South Texas..... **wiltii**
   Front at least one-sixth wider than high; pronotal disk immaculate or with three fuscous maculae placed in an inverted triangle at middle; elytra parallel-sided at least to middle, fasciae, if present, oblique; length 7-7.5. mm..... 9
9. Elytra just before apical third with a straight or nearly straight fuscous line set at an angle of about 70° with suture, not angulated nor interrupted, the pubescence behind this line generally reddish; pronotum scarcely more than one-half again as wide across lateral tubercles as long, lateral tubercles with a very short but distinct tooth; Southeastern States..... **moderator**
   Elytra before apical two-fifths with an oblique fuscous fascia, often angulated or interrupted, (but continuous in *crassulus*); pronotum usually strongly transverse..... 10
10. Elytra with post-median fuscous fascia set at an angle of 45° with suture, broadly interrupted and angulated toward side of disk; pronotal lateral tubercles scarcely dentate at apex, pronotum usually three-fourths again as wide as long; Texas..... **mimeticus**
    Elytra with post-median fascia set at an angle of 65° with suture, sometimes slightly undulating, often interrupted laterally but never angulated; pronotum about three-fifths again as wide as long, lateral tubercles ending in a distinct, often long, robust tooth; Lower California..... **crassulus**

Sternidius wiltii (Horn)

(Fig. 8)

Liopus Wiltii Horn, 1880, Trans. Amer. Ent. Soc. 8: 124.

Male: Dark reddish brown to black, densely covered with hoary pubescence, rather thickly and finely mottled with fuscous and often clouded here and there with fulvous. Elytra with the mottling condensed to form irregular maculae on basal gibbosity, laterally at basal third, and before apex, and usually also in the form of a narrow undulating fascia behind middle; disk with three or four rows of small, fuscous tufts. Femora (except profemora) basally fuscous-annulate at middle and narrowly so before apex; tibiae with a large fuscous macula near base and a broad annulus of the same color at apex; tarsi entirely fuscous. Antennae with all segments moderately broadly fuscous-annulate on apices and narrowly so on bases.

Upper surface minutely, densely alutaceous. Head with several coarse punctures in the deep median impression of vertex; front minutely punctulate and with a single setigerous puncture close to eye, feebly wider than high, strongly narrowed below eye; eyes with lower lobe quadrate, slightly taller than gena. Pronotum three-fourths again as wide as across lateral tubercles as long, sides gradually narrowing to apex, broadly constricted at base; lateral tubercles rather small, not prominent, armed with a short, robust tooth that is directed slightly caudad, placed at basal two-fifths; disk regularly tumid on anterior two-thirds, medially with three low tubercles arranged in an inverted triangle, rather densely punctate, but punctures largely concealed by the pubescence; basal transverse sulcus broad, continued laterally nearly to coxae, above without the distinct row of punctures that is evident on the sides. Elytra with basal gibbosity feebly prominent; disk uniformly, not

densely covered with rather coarse punctures and each with four low costae, which are provided with a number of long tufts of blackish pubescence; apices obliquely truncate at suture, usually rather broadly so, the angles not prominent. Metafemora reaching to middle of fifth sternite, which is slightly longer than fourth. Antennae nearly half as long as body, sixth segment attaining elytral apex, beneath without any long fringing hairs; scape elongate, attaining basal two-fifths of pronotum; third segment about one-tenth longer than first; rest gradually decreasing in length.

Female: Like male but fifth sternite tapering, nearly as long as third and fourth combined; metafemora slightly surpassing apex of fourth sternite; and antennae only one-third again as long as body.

Length, 7–9 mm.; width, 2.5–3.3 mm.

Distribution: South Texas. Texas: 3, Kingsville [CU]; 2, Dimmit Co., June 5, 1934 (S. E. Jones) [TAM]; 1, Winter Haven, May 12, 1936 [TAM].

Remarks: Distinguished by the robust,cylindrical form, by the black-variegated ashy coloration, and by the concealed punctation of the pronotal disk.

Sternidius crassulus LeConte

Sternidius crassulus LeConte, 1873, Smithson. Misc. Coll., 264, p. 235.

Although this species is not known to occur within the limits of the territory covered by this paper, since it has been erroneously reported from the area in the past, and since its abundance in Lower California places its occurrence in Southern California within the realm of possibility, a short synopsis, based on six specimens in the collection of the California Academy of Sciences, is provided here so that the form may be recognized if encountered.

In coloration somewhat intermediate between *S. wiltii* and *S. mimeticus*, but structurally closer to the latter, from which it differs as follows: Above broadly clouded with dull brown, especially on middle of pronotal disk and on elytra basally (often forming a vague sort of fascia across entire base), on sides (less extensively than in *mimeticus*), and apically. Elytra with the macula on anterior margin of humerus poorly defined, not very apparent, lateral marking likewise indistinct, postmedian fascia placed before apical two-fifths, forming about a 65° angle with suture, straight or curving feebly forwards towards sides, often much interrupted but never angulated; tufts somewhat more densely placed, especially at base and along sides.

Front not always so strongly convex; eyes with upper lobe often more than half as broad as interocular space. Pronotum tending to be less strongly transverse, averaging about four-sevenths again as broad across lateral tubercles as long, sides arcuately narrowing apically; lateral tubercles always with a coarse, distinct tooth at apex. Antennae as in *mimeticus*, but the third is scarcely longer than first and fourth distinctly shorter than first.

Length, 5.3–6.5 mm.; width, 2.1–2.5 mm.

Type locality: Cape San Lucas, Lower California.

Distribution: Known only from lower California.

Sternidius mimeticus Casey

Leiopus mimeticus Casey, 1891, Ann. New York Acad. Sci., 6: 49, 1913, Mem. Col. IV, p. 314 [ex parte].
Liopus crassulus LeConte. Horn, 1880, Trans. Amer. Ent. Soc. 8: 125. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 122. [misdet.]
Leiopus texanus Casey, 1913, Mem. Col. IV, p. 314 [new syn.].
Leiopus houstoni Casey, 1913, Mem. Col. IV, p. 315 [ex parte; new syn.].

Male: Dark reddish brown, head usually piceous; entirely covered with dense, hoary gray pubescence and broadly clouded with light fulvous-brown on middle of pronotal disk and on elytra, especially near base, around lateral dark macula, and behind the post-median fascia. Head, body beneath except abdomen, femora, and first antennal segments mottled with brownish. Pronotum on middle of disk with three fuscous maculae, often (especially the basal one) indistinct or entirely wanting. Elytra with a common, narrow, fuscous band outlining scutellum; humerus on anterior margin with a fuscous macula; behind humerus on sides a large fuscous or dark brown macula, extending somewhat onto disk and usually approaching side margin, almost always somewhat nebulose, occasionally nearly absent; just before apical two-fifths with a distinct fuscous fascia, placed at an angle of about 45° to the suture, broadly interrupted and angulated beyond middle of disk, not attaining side margin, sometimes margined anteriorly with whitish, sometimes with a second fascia at apical fourth, parallel to first, broad, indistinct; disk on basal three-fifths sprinkled with fine fuscous maculae or tufts, varying greatly in prominence, arranged in about five rows, which are often accentuated with whitish. Tibiae with a broad fuscous macula on apical third laterally and a small one near basal fourth; tarsi entirely fuscous. Antennae with second segment fuscous, third and following fuscous annulate apically, the fifth and following similarly annulate at base as well.

Head impunctate, rather broadly and dis-

FIG. 1. *Ceratographis biguttata* LeConte. FIG. 2. *Neacanthocinus obliquus obliquus* LeConte. FIG. 3. *N. obliquus pacificus* Casey. FIG. 4. *N. obsoletus* Olivier. FIG. 5. *Canonura leechi*, n. spec. FIG. 6. *C. spectabilis* LeConte. FIG. 7. *Sternidius fascicularis fascicularis* Harris. FIG. 8. *S. wiltii* Horn. FIG. 9. *S. moderator* Casey.

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tinctly impressed on vertex between eyes; front one-fifth wider than long, broadly convex, in profile forming a regular arc of a circle with vertex; eyes with lower lobe one-fourth again as tall as gena, scarcely taller than wide, oblong, upper lobes not quite half so broad as upper interocular space. Pronotum about three-fourths again as wide across lateral tubercles as long, sides strongly tapering to apex, broadly constricted at base; lateral tubercles rather prominent, continuous with sides, nearly unarmed at apex; disk with three small, rather distinct tubercles medially, finely punctate, the punctures largely concealed by the pubescence except at extreme base; basal sulcus very broad, shallow. Elytra with basal gibbosity nearly obsolete; disk rather finely punctate, the punctures largely concealed by the pubescence, each with four rather well marked costae, which are broadly interrupted at basal third and provided with small, sometimes tufted tubercles; apices rather broadly, feebly obliquely truncate, the angles only rarely prominent; Metafemora almost attaining apex of abdomen, distinctly clavate but not nearly so strongly as are the mesofemora. Fifth sternite about one-third again as long as fourth. Antennae three-fifths to three-fourths again as long as body, with a few long fringing hairs beneath near apex of scape, elsewhere not fimbriate; scape attaining basal two-fifths of pronotum; third segment about one-seventh longer than first; fourth distinctly shorter than third, subequal to, or slightly shorter than, first; rest gradually decreasing in length.

Female: Similar to male but metafemora slender, scarcely clavate, reaching to basal third of fifth sternite, which is subequal in length to third and fourth combined.

Length, 4.8–7.0 mm.; width, 2.0–2.8 mm.

Type localities: Brownsville, Texas [*texanus; houstoni*]; Texas [*mimeticus*].

Distribution: South Texas. Texas: 39, Brownsville, May-June, 1932 (E. G. Linsley) [CAS; KU; AMNH]; 2, Uvalde, June [CAS]; 2, Olmos, May, July [CAS]; 1, Comal Co. [AMNH]; 4, College Station, June, 1952 (E. S. and L. S. Dillon) [author's collection]; 9, College Station Apr. 14–Sept. 17 (H. J. Reinhard) [TAM]; 6, Dimmit Co., Apr.–May [TAM]; 4, Hidalgo Co. [TAM]; 2, Mexia, Sept., Oct. [TAM]; 2, Richmond [CU]; 4, Cypress Mills, Sept.–Nov. [AMNH].

Remarks: While in *houstoni* the elytral lateral plaga is described as being blacker and more sharply defined than in *mimeticus* proper, that character is so variable that it can in no way be considered as diagnostic; all stages of intensity occur from a faint fuscous clouding to a quite sharply defined blackish area, with the intermediate condition being most prevalent.

In his original description of *mimeticus*, Casey confounded two species, this one from Texas and a second, which he later redescribed as *moderator*, from District of Columbia. While his description is based largely on the latter, the type is as given above.

While the whitish pubescence of the upper surface will in most cases serve to distinguish this species from *alpha*, the occasional darker specimens may be recognized by the more robust form of the body, the pronotum being three-fourths again as wide across the lateral tubercles as long (instead of only one-half wider than long), the sides strongly tapering. Moreover, the lateral tubercles are almost unarmed at apex; and the fourth antennal segment is distinctly shorter than the third, being only as long as first, or even feebly shorter.

Sternidius schwarzi Hamilton

Liopus schwarzi Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 124.

From Hamilton's original description, based on a single specimen from Key West, Florida, this species appears to be very close to *S. moderator* Casey but differs in having the elytral fascia arcuate and placed even further posteriorly (at apical fourth instead of apical third) and in having the femora luteous with a fuscous annulus near middle. A copy of the original description follows:

"Length 6.5 mm. Very robust, elongate, convex, brownish when denuded, densely clothed with fine whitish gray pubescence concealing the punctures; antennae a little longer than the body, incisures black, upperside spotted; thorax wider than long, basal constriction deep, the tubercles each side small and pointed, pubescence dense, punctulation fine and close, disc with a tubercle on each side of middle behind front margin and one on centre; scutellum rounded, pubescent; elytra margin, suture, and four slightly elevated lines on each bearing remotely placed black dots, humeral angles polished black; stripe on margin obscure by denudation, at apical fourth a conspicuous, arcuate, black band attaining the sides, behind this another obscurely fuscous, punctuation fine, evanescent toward apices, which are obliquely truncate; legs luteous, femora fuscous at middle, tarsi and apex of tibiae black, abdomen finely punctured, pubescence rather sparse."

Sternidius moderator (Casey)

(Fig. 9)

Leiopus mimeticus Casey, 1891, Ann. N. Y. Acad. Sci. 6: 48 [ex parte].
Leiopus crassulus LeConte. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc., 23: 124 [ex parte; misdet.].
Leiopus moderator Casey, 1913, Mem. Col. IV, p. 314.

Male: Dark reddish brown, densely covered with short, bright cinereous pubescence, indistinctly clouded with dull brown on head, pronotum, and sides of elytra. Head, body beneath, legs, and antennae on first six or seven segments,

indistinctly mottled with brownish, often obsoletely so. Pronotum medially with three barely perceptible brown maculae. Elytra around scutellum narrowly margined with fuscous; disk more or less sprinkled with fine fuscous tufts; humeri on anterior margin with a very prominent, fuscous macula; sides on basal half with a vague fuscous or nebulous brown area; just before apical third with a fine, straight, prominent, fuscous fascia placed at about a 70° angle with the suture, not interrupted nor angulated toward side, at apical fourth sometimes a second fascia parallel to the first but this is always broad, poorly defined, and never distinct; apical area beginning usually behind the first fascia, but occasionally only behind the second, covered with ferrugineous pubescence. Tibiae (except metatibiae occasionally) broadly fuscous. Antennae with segments beginning with second distinctly fuscous annulate on apices and, beginning with sixth, narrowly so basally as well.

Head virtually impunctate, scarcely impressed above between eyes; front one-sixth wider than high, sides parallel between eyes, constricted below; eyes with lower lobe oblong, one-third again as tall as gena, upper lobe one-half as broad as interocular space. Pronotum one-half again as wide across lateral tubercles as long, sides arcuately narrowed to apex, constricted at base; lateral tubercles not prominent, armed at apex with a small but quite distinct tooth; disk with three small, distinct tubercles medially, rather densely covered with fine punctures; basal sulcus well impressed. Elytra with basal gibbosity rather prominent; disk moderately finely and densely punctate, the punctures finer and sparser apically, partially concealed by the pubescence, each disk with four feebly elevated costae which are sparsely provided with low tufted tubercles; apices distinctly obliquely truncate, often emarginately so, at least outer angle somewhat prominent. Metafemora clavate, nearly equal in thickness to mesofemora, attaining basal third of fifth sternite, which is one-third longer than fourth. Antennae scarcely one-half again as long as body, not fimbriate beneath; scape reaching close to basal third of pronotum; third segment very feebly longer than first; fourth distinctly shorter than first; rest, including eleventh, successively shorter.

Female: Metafemora as long as in male but less strongly clavate, being distinctly more slender than mesofemora; fifth sternite as long as third and fourth combined. Rest as in male.

Length, 5.6–7.5 mm.; width, 2.3–2.8 mm.

Type locality: District of Columbia.

Distribution: Southeastern States. District of Columbia: 1, no further data [Minn.]. North Carolina: 2, Chapel Hill, June (J. Valentine) [AMNH]. Florida: 4, Dunedin, Mar., Apr. (W. S. Blatchley) [CAS; CU]; 1, Fort Myers, Mar. [AMNH]; 1, Gainesville, Sept.–Oct. (M. Cazier) [AMNH]; 1, Lakeland, Nov. 7 [AMNH]; 1, Crescent City, Apr. [USNM]; 1, Archer, Mar. [USNM]. Louisiana: 3, no further data [Minn.; KU].

Remarks: While this species superficially resembles *mimeticus* Casey, it is not really closely related to it. It is most easily distinguished by the straight, uninterrupted and unangulated fuscous fascia of the elytra, which is placed just before apical third at quite an obtuse angle (about 70°) with the suture, with the area behind the fascia distinctly tinged with reddish brown. In addition the pronotum is only one-half again as wide as long and has a distinct tooth on the rounded lateral tubercles; the antennae are not more than one-half longer than body, with the third segment scarcely longer than first and the fourth distinctly shorter than the latter; and the elytra have subprominent basal gibbosities, while the apices are rather strongly obliquely truncate and often emarginately so.

Sternidius fascicularis fascicularis Harris

(Fig. 7)

Lamia (*Mesosa*) *fascicularis* Harris, 1836, Trans. Hartford Nat. Hist. Soc., 1: 68, pl. 1, fig. 9.

Leptostylus fascicularis (Harris). LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, (2)2: 170.

Amniscus punctatus Haldeman, 1847, Trans. Amer. Philos. Soc. (2)10: 49.

Sternidius punctatus (Haldeman). LeConte, 1873, Smiths. Misc. Coll. 264, p. 235.

Liopus punctatus (Haldeman). Horn, 1880, Trans. Amer. Ent. Soc. 8: 124. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 125. Blatchley, 1910, Col. Ind., p. 1075. Casey, 1913, Mem. Col. IV, p. 311. Knull, 1946, Bull. Ohio Biol. Surv. 39: 249, fig. 109.

Male: Dull orange-brown to deep ferrugineous, head and scutellum darker; sparsely covered with fine cinereous pubescence. Head above usually with an elongate, triangular, fuscous macula each side of middle; front irregularly fuscous-variegate. Pronotum medially faintly clouded with brown or fulvous, and with three rounded, fuscous maculae arranged in an inverted triangle, the median one often indistinct. Elytra dull fulvous pubescent, indistinctly varied with white dots and, just behind middle, with a rather broad, transverse, white fascia; this fascia is biflexuose (its posterior border, however, often is arcuate) and is placed directly transverse from the suture nearly to side margin; each disk with four distinct rows of short, blackish tufts; sides behind humeri to middle broadly but very indistinctly clouded with fuscous. Body beneath and legs very sparsely cinereous or chalky pubescent; femora coarsely mottled with brown; tibiae brown-annulate near base and broadly fuscous-annulate before apex; tarsi largely fuscous, first segment annulate with ashy at base. Antennae sparsely ashy pubescent, the first five or six segments coarsely mottled with brown, all segments distinctly fuscous-annulate apically, the bases of sixth and following segments narrowly so.

Head with a few fine punctures in the broad, deep impression on vertex; front with three or four fine, setigerous punctures near each eye, about one-fourth wider than high, strongly narrowed below eyes, feebly so between them; eyes with lower lobe variable in size and shape, at least feebly transverse and ranging from one-half to one-fourth again as tall as gena, isthmus ranging from one to three facets in width. Pronotum at least two-thirds again as wide across lateral tubercles as long, sides gradually narrowing apically, strongly constricted at base; lateral tubercles small, rounded, with a very short tooth at apex; disk very densely, finely, uniformly punctate, with three scarcely evident tubercles arranged in an inverted triangle at middle; basal transverse sulcus broad, not well defined. Elytral basal gibbosities feebly prominent, usually with an elongate but low crest; disk coarsely, deeply punctate, punctures gradually becoming slightly finer apically, with four more or less prominent costae which bear low, tufted tubercles; apices emarginate, with both angles usually prominent. Metafemora nearly attaining apex of abdomen, strongly clavate. Fifth sternite subequal to fourth. Antennae two-fifths again as long as body, not fimbriate beneath; scape reaching slightly behind middle of pronotum; second segment about twice as long as wide; third segment one-fourth again as long as first; fourth slightly longer than first; rest successively feebly shorter.

Female: Similar to male, but metafemora weakly clavate, attaining apex of fourth sternite; fifth sternite nearly as long as third and fourth combined.

Length, 4.5–6 mm.; width, 1.8–2.2 mm.

Type locality: North America [*fascicularis; punctatus*].

Distribution: Southeastern United States. New Jersey: 1, Franklinville, June 19, 1939 (J. C. Bradley) [CU]. Maryland: 3, no further data [Minn.]. District of Columbia; 2, no further data [Minn.]. Virginia: 2, no further data [Minn.].

Remarks: The transverse white fascia placed just behind the middle of the elytra will suffice to distinguish this species. An additional peculiarity is the elongate second antennal segment, which is about twice as long as wide.

Sternidius fascicularis maculipennis (Blatchley)

Leiopus maculipennis Blatchley, 1922, Can. Ent. 45: 31.

Male: Nearly identical to the typical form but the elytral white fascia is narrower and does not approach so close to the suture. Moreover the isthmus of the eye is a little wider, being of three or four facets in width.

Length, 5.5–6.5 mm.; width, 2.0–2.3 mm.

Type locality: Dunedin, Florida.

Distribution: Known only from the type locality. Florida: 2, Dunedin, March 16, 1918 (W. S. Blatchley) [Purdue—paratypes].

Remarks: The author is indebted to Dr. J. J. Davis for enabling him to study two of six specimens of this form now in the Blatchley collection at Purdue University.

Sternidius alpha alpha (Say)

Lamia alpha Say, 1826, Journ. Acad. Nat. Sci. Philadelphia, 5: 270.

Amniscus alpha (Say). Haldeman, 1847, Trans. Amer. Philos. Soc., (2)10: 48.

Liopus alpha (Say). LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia (2)2: 172. Horn, 1872, Trans. Amer. Ent. Soc. 8: 124. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 124.

Amniscus alpha var. *divergens* Haldeman, 1847, Trans. Amer. Philos. Soc. 2(10): 48.

Amniscus lateralis Haldeman, 1847, Trans. Amer. Philos. Soc. 2(10): 48.

Liopus rusticus LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, (2)2: 173.

Liopus cinereus LeConte. Horn, 1872, Trans. Amer. Ent. Soc., 8: 124 [misdet.].

Leiopus cinereus LeConte. Casey, 1913, Mem. Col., p. 313 [misdet.].

Leiopus vicinus Haldeman. Casey, 1913, Mem. Col. IV, p. 312 [misdet.]

Leiopus timidus Casey, 1913, Mem. Col., p. 313 [new syn.].

Leiopus obscurellus Casey, 1913, Mem. Col., p. 313 [new syn.].

Male: Ferrugineous to dark reddish brown, rather sparsely covered with fulvous-cinereous pubescence. Head on occiput with two small, and on anterior surface of each antennal tubercle with two large, fuscous maculae. Pronotum on sides, especially basally, more or less hoary pubescent; at middle of disk with three rather small, elongate, fuscous maculae arranged in an inverted triangle, the two anterior ones somewhat oblique, placed very close to anterior margin, the median one occupying most of basal two-fifths. Scutellum fuscous on basal angles, finely margined with hoary at apex. Elytra with a narrow, common, fuscous, circumscutellar patch; on sides fuscous-vittate from anterior margin of humerus nearly to middle and sometimes behind that point, posteriorly remote from side margin and narrowly ascending onto disk, occasionally narrowly interrupted behind humerus and variable in prominence; each with a fine dark brown or fuscous fascia extending from middle of suture at about a 40° angle, not attaining side margin, usually interrupted and angulated medially, accentuated by three or four fuscous tufts, that nearest suture larger than rest, preceded by a broad, poorly defined, hoary fascia, the pubescence behind the dark fascia usually darker than that on rest of disk and often streaked or clouded with hoary; disk at base and near middle sprinkled with a number of distinct fuscous tufts. Legs and antennae cinereous (as is also the body beneath), coarsely mottled with brownish; tibiae rather narrowly near base and broadly at apex, annulate with fuscous; tarsi entirely fuscous; antennal

segments broadly annulated with fuscous at base and apex.

Entire upper surface finely alutaceous. Head above with a few rather coarse punctures between eyes; front one-fourth wider than high, somewhat narrowed between and below eyes, strongly convex, with single setigerous puncture near eye; eyes with lower lobe quadrate or feebly transverse, ranging from one to one and one-fourth times as tall as gena. Pronotum more than half again as wide across lateral tubercles as long; sides slightly tapering to apex, constricted at base; lateral tubercles small, not prominent, armed with a short, obtuse tooth which is directed nearly directly laterad; disk obsoletely trituberculate, densely, finely punctate, the punctures a little coarser at base; basal sulcus poorly defined. Elytra with basal gibbosities not large but rather prominent; disk moderately coarsely, rather sparsely punctate, each with four indistinct costae which are studded medially and at base with small, prominent, tufted tubercles, especially prominent on basal gibbosity; apices narrowly, obliquely truncate at suture, the outer angle subdentate, the inner one sometimes slightly prominent. Metafemora scarcely more slender than mesofemora, nearly attaining apex of fifth sternite, which is almost half again as long as fourth. Antennae one-half to three-fifths again as long as body, not fimbriate beneath; scape extending to basal two-fifths of pronotum; second segment one-fourth longer than wide as a rule; third segment one-seventh again as long as first; fourth subequal to third; rest gradually decreasing in length.

Female: Very similar to male but metafemora much more slender than mesofemora, extending only to base of fifth sternite, which is nearly as long as third and fourth together.

Length, 5–7.5 mm.; width, 2.0–2.3 mm.

Type localities: Pennsylvania [*alpha; divergens; timidus lateralis*]; western New York [*rusticus*]; Bluff Point, New York [*obscurellus*].

Distribution: New England and Middle Atlantic States. Massachusetts: 1, Chicopee [CU]; 2, Cambridge, May [RA]; 5, Plymouth Co. [CU]. Connecticut: 9, Cornwall, May-July [CU]; 2, New Haven, June-July [CU]; 1, Avon [RA]. New York: 12, Ithaca, May-Aug. [CU]; 1, Lynbrook [Minn.]; 1, Yonkers [CU]; 1, Clinton Co. [CU]; 2, Rochester Junction [CU]; 1, Medina [RA]; 1, Oswego [RA]; 1, Millwood [RA]; 15, Olcott [CU]. Pennsylvania: 9, Hummelstown, June 17, 1933, (J. N. Knull) [OSU]; 2, Castle Rock [OSU]; 9, Frankfort [USNM]; 3, Angora [USNM]; 11, Philadelphia [USNM]. New Jersey: 1, Millville [Minn.]; 2, Boonton, June 16 [USNM]; 1, Riverton [USNM].

Remarks: While specimens collected at any one place at the same time tend to be quite uniform, the members of this species are remarkable, even in this tribe where variability is a rule, for their extreme variation from year to year and from locality to locality. This fact must be borne in mind when the attempt is made to determine specimens to subspecies. In fact the subspecies as described here only indicate general tendencies and will indeed not apply to all specimens from a given region.

Moreover, throughout the entire range of the subspecies there occur, in considerable numbers, specimens in which the pronotal and elytral markings are very dim; usually, however, the markings are discernible if the insect is held obliquely when viewed and if the light is not too intense.

This species may be distinguished by the following combination of characters: Front transverse, about one-fourth again as wide as high, strongly convex, it and vertex together forming nearly a regular arc; lower ocular lobe at least subequal to gena in height, upper lobes separated by twice their width; pronotal lateral tubercle feebly prominent, armed with a short tooth that points nearly directly laterad, the pronotum slightly more than half again as wide across lateral tubercles as long; elytra marked with fuscous as rows of dots or tufts, as a cloud, a large area, or a vitta on sides of basal half, and as an outline around the scutellum, the post-median dark fascia placed at an angle of 45° or less; and the antennal fourth segment is subequal to the third which is one-seventh or more again as long as first.

In this subspecies the most typical examples occur in New England; examples from Pennsylvania, western New York, and New Jersey show strong intergradational characters with the adjacent subspecies.

Sternidius alpha vicinus Haldeman

Amniscus vicinus Haldeman, 1847, Trans. Amer. Philos. Soc. (2)10: 49.
Liopus cinereus Le Conte, 1852, Jour. Acad. Nat. Sci. Philadelphia (2)2: 173 [new syn.].
Liopus alpha Say. LeConte, 1852, Jour. Acad. Sci. Philadelphia (2)2: 172 [ex parte].
Leiopus testaceus Casey, 1913, Mem. Col. IV, p. 311 [new syn.].
Leiopus pleuralis Casey, 1913, Mem. Col. IV, p. 312 [new syn.].
Leiopus crinicornis Casey, 1924, Mem. Col. XI, p. 291 [new syn.].
Leiopus nelsonicus Casey, 1924, Mem. Col. XI, p. 291. [new syn.].

In this subspecies, there is a trend for the pubescence of the upper surface to become uniformly pale ashy, while the dark maculation becomes reduced, except the sharply defined lateral mark and the first (sutural) fuscous tuft in the post-median fascia of the elytra.

Length, 3.5–7 mm.; width, 1.5–2.6 mm.

Type localities: United States [*vicinus*]; Georgia [*cinereus*]; District of Columbia [*testaceus; pleuralis*]; Nelson Co., Virginia [*crinicornis; nelsonicus*].

Distribution: Southeastern United States.

Maryland; 17, no further data [Minn.]; 13, Odenton, June-July (H. Dietrich) [CU]; 11, Plummer's Isl. [USNM.]. District of Columbia: 4, no further data [Minn.]; 2, Washington [USNM]. Virginia: 3, no further data [Minn.]; 1, Cape Henry, May [USNM]; 8, Falls Church [USNM]. Florida: 1, no further data [Minn.]; 2, Enterprise [LL]. Georgia: 2, Fort Valley, May [USNM]. Alabama: 3, Mobile, June [CAS]; 2, Mobile Co. [CAS]; 2, Thomasville [USNM]. Mississippi: 30, Lucedale, April-July [CU].

Sternidius alpha misellus LeConte

Liopus misellus LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia (2)2: 173.
Liopus xanthoxyli Shimer, 1868, Trans. Amer. Ent. Soc. 2, proc. p. vii. [new syn.].
Liopus alpha (Say). Blatchley, 1910, Col. Ind., p. 1074 [misdet.].
Leiopus alpha (Say). Casey, 1913, Mem. Col. IV, p. 314 [misdet.].
Liopus crassulus LeConte. Blatchley, 1910, Col. Ind. p. 1074 [misdet.].
Liopus fascicularis Harris. Blatchley, 1910, Col. Ind., p. 1074 [misdet.].
Leiopus dentatus Casey, 1913, Mem. Col. IV, p. 310 [new syn.].
Leiopus scapalis Casey, 1913, Mem. Col. IV, p. 312 [new syn.].
Leiopus houstoni Casey, 1913, Mem. Col. IV, p. 315 [ex parte].

As unstable in coloration as the typical form, ranging from pale ashy pubescent forms with the dark maculation reduced to the lateral vitta and one or two post-median maculae (resembling *a. vicinus*, and the form to which the name *misellus* originally applied) to a larger, more abundant, form (to which the name *xanthoxyli* was originally applied) which differs from the nymotype as follows: Integument of head and undersurface often piceous, pubescence of entire body rather sparse, cinereous, often fulvocinereous on the elytra. Elytra with the lateral dark marking in the form of a large, semicircular macula, not attaining (typically) the humerus but extending to side margin and to middle of disk, often nebulous; circumscutellar fuscous marking often extensive but irregular in form; post-median fascia placed at an angle of 45°-50° with suture, typically followed by a similar, less distinct fascia, parallel to it, placed at apical fourth of suture; disk with fuscous tufts or maculae (sometimes dim). Lower ocular lobe tending to be somewhat larger than in nymotype.

Length, 4-7 mm.; width, 1.8-2.5 mm.

Type localities: Illinois [*miscellus; dentatus*]; Mount Carroll, Illinois [*xanthoxyli*]; Indiana [*scapalis*].

Distribution: Central States from Ohio and West Virginia west to North Dakota, Arkansas, and Texas. West Virginia: 4, no further data [CU]. Ohio: 23, Delaware Co., June-Aug.; 4, Dean Forest; 3, Jackson Co.; 21, Hocking Co.; 7, Greene Co.; 3, Columbus; 15, Lucas; 3, Franklin Co.; 4, Scioto, June; 3, Put-in-Bay; 4, Clifton; [all OSU]. Michigan: 1, no further data [Minn.]. Indiana: 4, no further data [CU]; 1, Washington, May [Minn.]; 2, Marion Co. [CU]. Illinois: 1, Rock Island [Minn.]. Wisconsin: 2, no further data [Minn.]; 1, Platteville, July [Minn.]. Minnesota: 5, Itasca Co., June [Minn.]; 2, Moorehead [Minn.]; 1, Cass Co. [Minn.]; 1, Polk Co., July [Minn.]; 1, Lake Johanna [Minn.]; 2, Crookston, July [Minn.]; 1, Norman Co. [Minn.]; 1, Kondeyohi Co., June [Minn.]; 1, Walbo, June [Minn.]; 2, Minneapolis [Minn.; CU]; 3, Ramsey Co., June-July [Minn.]; 1, Rochester [Minn.]; 2, Mora [Minn.]; 1, Taylors Falls [Minn.]; 4, Hennepin Co. [Minn.]; 1, St. Paul [Minn.]. Iowa: 2, Leon, July 8 [TAM]; 1, Ames [CU]; 2, Sioux City, from sumac [Minn.]; 1, New Albion, May [Minn.]. North Dakota: 1, Souris [Minn.]. South Dakota: 3, Elk Point [Minn.]. Missouri: 1, Rock, Aug. [CAS.]. Arkansas: 4, Hope, May [CU]. Kentucky: 1, Jane [CAS]. Tennessee: 1, Crabtree, July [CU]. Texas: 23, College Station, Apr.-Aug. (H. J. Reinhard) [TAM]; 7, Dickinson, Aug., from fig twigs [TAM]; 1, Morris Co. [TAM]; 9, Brownsville, [CAS.] (The Austin specimen of *houstoni* listed by Casey probably belongs here.)

Sternidius alpha coloradensis

Dillon, subspec. nov.

Male: In the pale hoary pubescence of the upper surface, this form most closely resembles *a. misellus*, but in maculation it recalls the typical race. From the latter it otherwise differs in having the elytral lateral vitta greatly elongated, reaching from anterior margin of humerus to apical two-fifths, the postmedian fascia beginning at middle of suture, strongly oblique, subobsolete beyond middle of disk.

Length 5.5–6.5 mm.; width 1.9–2.1 mm.

Holotype: Male; Colorado Springs, Colorado, June, 1926 (E. G. Linsley) [CAS.].

Allotype: Female; Colorado (Snow) [KU].

Paratype: 1, topotypic, reared from *Salix*, May 18, 1915 (Geo. Hofer) [USNM]; 1, Assinbone, Montana [USNM].

Sternidius alpha nigricans

Dillon, subspec. nov.

Very close in maculation to Arkansas examples of *a. misellus*. However, here the pubescence of the upper surface is nearly hoary, the pronotum medially only feebly tinged with brown. Elytra with basal gibbosity covered by a large, blackish macula; lateral macula blackish, extending to or beyond middle of disk; post median fascia less strongly oblique than is usual in the species, placed at an angle of about 55°–60° with suture, the preapical fascia very poorly defined.

Length 5.1–6.0 mm.; width 2.0–2.1 mm.

Holotype: Female; Tajique, New Mexico, June 26, 1941 (R. H. Beamer) [KU].

Paratypes: Female; Hot Springs, New Mexico, July 21, 1936 [KU]. Female; Jemez Mts., June 12 [CAS].

Sternidius alpha arizonensis

Dillon, subspec. nov.

Female: Pubescence above hoary; elytra with lateral macula rather small, dark brown, disk at base with a large, nearly semicircular, dark brown macula, post-median fascia broad, in width equal to about one-eighth of elytral length, placed just before apical two-fifths and only feebly transverse, forming a 75°–80° angle with suture, area behind fascia largely hoary.

Length 4.2 mm.; width 1.3 mm.

Holotype: Female; Cave Creek, Chiricahua Mts., Arizona, July 4, 1930 (J. O. Martin) [CAS].

Paratype: 1, Huachuca Mts., Arizona, June 9 (J. N. Knull) [OSU]; 27, Chiricahua Mts. (Hubbard & Schwarz) [USNM]; 3, Huachuca Mts. [USNM]; 1, Tucson [USNM]; 1, Bear Canon, Catalina Mts. [USNM].

Sternidius floridanus Hamilton

Liopus alpha var. *floridanus* Hamilton, 1896, Trans. Amer. Ent. Soc., 23: 125.

Very similar to *alpha* in coloration, structure, and variability, differing from that species primarily as follows: Pubescence of upper surface much darker, ranging from dull brownish cinereous to dark sooty brown. Elytra with basal lateral dark marking never vittiform, always macular, usually nebulose, the post-median fascia as in *alpha*, often with another parallel to it as in one form of *a. misellus*. Legs somewhat more heavily mottled, as are also the antennae, the third segment of which is frequently nearly entirely fuscous except at extreme base. Eye with lower lobe much larger, twice as tall as gena, quadrate, encroaching on the front so that the latter is scarcely wider than high, upper lobe of eye likewise enlarged, three-fifths as wide as upper interocular space.

Length 4.5–6.5 mm.; width 1.6–2.3 mm.

Type locality: Bay Biscayne, Florida.

Distribution: Known only from Florida. Florida: 2, Gainesville, July 7, 1927 (J. S. Rogers) [CU]; 2, Miami, June 21, 1944 (V. M. Kirk) [PDES]; 1, Dade Co., May 12, 1939 (D. J. and J. N. Knull) [OSU]; 2, Jacksonville, Aug. [OSU]; 2, Bradenton, Mar. 6 (W. Benedict) [KU].

Remarks: Were it not for the large eyes and the narrow front, this would have to be placed as a subspecies of *alpha*. However, in the somewhat limited material from Florida at hand, there was no indication of intergradation between the two forms.

Sternidius imitans Knull

(See Fig. 1 of Part III)

Leiopus imitans Knull, 1936, Ent. News 47: 107.

Female: Dark ferrugineous to piceous, rather densely covered with bright cinereous pubescence. Head, antennae, femora, tibiae, and metasternum rather strongly mottled with dark brown or fuscous. Pronotum with three large, round, fuscous maculae arranged in an inverted triangle at middle, the median macula usually elongated, subvittiform. Elytra each with five rows of small maculae composed of tufts of short, fuscous hairs and with two subequal, somewhat larger, fuscous maculae, one behind humerus on sides, scarcely extending onto disk and quite remote also from side margin, the second nearly on suture, subquadrate. Tibiae broadly fuscous-annulate apically and sometimes indistinctly so laterally near base; tarsi entirely fuscous. Antennal segments from second narrowly annulate with fuscous on apices, those from sixth similarly annulate basally as well, all annulations gradually becoming broader distally.

Head above with a very few coarse punctures between eyes; front feebly wider than high, somewhat convex, sides indistinctly narrowed between eyes, more strongly so below, with a single, coarse, setigerous puncture near each eye; eyes with lower lobe broadly oblong, erect, one-sixth again as tall as gena. Pronotum about one-half again as wide across lateral tubercles as long, sides broadly arcuately narrowed to apex, constricted at base; lateral tubercles low, armed at basal fourth with a short, subacute tooth, which is directed slightly caudad; disk feebly trituberculate, densely, rather finely punctate over entire surface; basal transverse sulcus distinct, broad. Elytra with basal gibbosity broad, slightly prominent; entire disk densely, moderately finely punctate, costae subobsolete, slightly indicated at base and on apical third, each costa provided with a row of low tufted tubercles; apices separately rather broadly rounded. Metafemora feebly exceeding apex of fourth sternite. Fifth sternite distinctly longer than fourth. Antennae three-fifths again as long as body, not fimbriate beneath; scape extending slightly behind middle of pronotum; third segment one-fifth again as long as first; fourth a little longer than first; rest gradually diminishing in length.

Length 5–7 mm.; width 2.0–2.8 mm.

Type locality: Davis Mountains, Texas.

Distribution: West Texas. Texas: 3, Davis Mts. June–July (D. J. and J. N. Knull) [OSU; LL-paratype]; 1, Chisos Mts. Brewster Co., July 18 (J. W. Green) [CAS].

Remarks: While this species is rather closely related to *centralis* in the form of the front and of the lower ocular lobe, as well as in color pattern, it is readily distinguished in having the lateral macula of the elytra quite small, subequal to

the post-median spot, and in having the lower lobe of eye distinctly erect.

Sternidius centralis LeConte

(See Figs. 2, 3 of Part III)

Liopus centralis LeConte, 1884, Trans. Amer. Ent. Soc. 12: 24. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 123.

Liopus decorus Fall, 1907, Jour. New York Ent. Soc. 15: 84. [new syn.].

Male: Ferrugineous to fuscous, moderately densely covered with bright cinereous pubescence, often irregularly clouded with pale olive-brown, especially on elytra. Head on vertex often with two large, elongate, brown or fuscous maculae each side of middle. Pronotum medially with three rounded, fuscous maculae (two anteriorly, one medially toward base), often more or less coalescent and sometimes reduced or nearly wanting or obscured by a fuscous cloud. Elytra on sides with a large, triangular, fuscous macula, its base placed along lateral margin from basal sixth to middle, its apex attaining middle of disk, and with a fuscous fascia extending from apical two-fifths at suture to apical fourth laterally, towards sides interrupted or wanting, sometimes reduced to a common, triangular macula; behind this fascia there is often a similar but less extensive and more poorly evident fascia, placed parallel to the first; entire disk sprinkled irregularly with tufted black maculae which tend to become more densely concentrated on basal fifth and near middle of length. Body beneath and legs ashy pubescent; femora indistinctly mottled with brownish; tibiae broadly fuscous-annulate at apex, at least laterally, sometimes indistinctly brown maculate near base; tarsi entirely fuscous. Antennal segments becoming pale ferrugineous from third, rather sparsely ashy pubescent, irregularly and coarsely mottled with brown, apices of all segments from second and bases narrowly from sixth, annulate with fuscous.

Head impunctate, above rather feebly impressed at middle; front feebly wider than high, slightly narrowed between and below eyes, slightly convex, with a single setigerous puncture near each eye; eyes with lower lobe quadrate, slightly taller than gena. Pronotum more than one-half again as wide across lateral tubercles as long; sides gradually narrowing apically, strongly constricted at base; lateral tubercles slightly prominent, armed with a short, robust, obtuse tooth that is directed slightly caudad; disk with the three median tubercles scarcely elevated, entirely covered with moderately fine, closely set punctures; basal sulcus broad, not very deeply impressed. Elytra with basal gibbosity feeble; disk entirely covered with rather dense, coarse punctures, each with four indistinct costae which bear small, scarcely elevated, tufted tubercles; apices separately rounded or narrowly, squarely truncate. Metafemora slightly more slender than mesofemora, attaining apex of abdomen. Fifth sternite feebly longer than fourth. Antennae two-thirds again as long as body, not fimbriate beneath; scape extending to basal two-fifths of pronotum; second segment one-fifth longer than wide; third segment one-third longer than first; fourth feebly shorter than third; rest gradually decreasing in length.

Female: Metafemora much slenderer than mesofemora, attaining apex of fourth sternite; fifth sternite half again as long as fourth; antennae only half again as long as body; rest as in male.

Length 4.5–7.2 mm.; width 1.5–2.3 mm.

Type localities: Arizona [*centralis*]; Williams, Arizona [*decorus*].

Distribution: Known only from Arizona. Arizona: 1, Flagstaff, Aug. 1, 1943 (Jean Russell) [KU]; 2, Tucson, July-Aug. [CAS; CU]; 1, Carr Canyon, June 23 (E. G. Linsley) [CAS]; 1, Senator [AMNH]; 1, Arivaca, July 12 (L. C. Kuitert) [KU]; 1, Oslar [AMNH]; 2, Santa Rita Mts., July (F. H. Snow) [KU]; 1, Cochise Co., June [CAS]; 1, Huachuca Mts. (M. A. Cazier) [AMNH]; 1, Oak Creek Canon, 6,000 ft., July (F. H. Snow) [KU]; 1, Williams [USNM].

Remarks: The variety described as *decorus* by Fall cannot be separated from *centralis* in a series of this very variably colored species.

The slender body form, the large fuscous lateral macula, and the suturally expanded dark fascia on the elytra, and scarcely transverse front are diagnostic characters.

Sternidius suturalis Dillon, spec. nov.

Male: Orange-ferrugineous, moderately densely covered with bright cinereous pubescence, broadly clouded with pale fulvous often on pronotal disk and on elytra, especially along suture, on sides, and on apical third. Head, body beneath, femora, and first five antennal segments indistinctly mottled with light brown. Pronotum with three small, fuscous maculae, the median one greatly elongate. Elytra with a narrow, circumscutellar, fuscous margin that is prolonged as a vitta along suture to middle; on sides a broad, prominent, fuscous vitta extending from anterior surface of humerus to middle, sometimes interrupted below humeral angle, not ascending onto disk; post-median fuscous fascia composed of two large tufts, sometimes coalescent, placed along anterior border of apical fulvous area which is prolonged to middle of suture with which it forms an angle of about 35°; disk very sparsely sprinkled with fuscous tufts. Tibiae on apical third and tarsi entirely fuscous. Antennae with apices of segments from second narrowly and indistinctly fuscous-annulate.

Head very finely punctate in the rather strong median impression on vertex; front nearly one-third again as wide as high, slightly narrowed between eyes, more strongly so below, moderately

convex, in profile not forming a continuous arc with vertex; eyes with lower lobe quadrate, at least slightly taller than gena; upper lobe nearly one-half as wide as upper interocular space. Pronotum somewhat more than half again as wide as long, sides subarcuately narrowed to apex, not strongly constricted at base; lateral tubercles feebly prominent, briefly but distinctly dentate; disk rather indistinctly trituberculate at middle, densely, finely punctate; basal transverse sulcus broad and shallow. Elytra with basal gibbosity slightly prominent; disk fairly densely punctate, the punctures largely concealed by pubescence, each disk with four distinct but interrupted costae which bear a very few low, sometimes tufted tubercles; apices rather broadly, obliquely truncate. Metafemora nearly as strongly clavate as mesofemora, reaching almost to apex of abdomen. Fifth sternite one-half again as long as fourth. Antennae one-half again as long as body, with only one or two long fringing hairs beneath near apex of scape; scape attaining basal third of pronotum; third segment about one-third again as long as first; fourth slightly shorter than third; rest gradually diminishing in length.

Length 5.3–6 mm.; width 2.0–2.1 mm.

Holotype: Male; Rockdale, Texas, Apr. 26, 1935 [TAM].

Paratypes: 1, College Station, Texas, Apr. 18, 1934 (H. J. Reinhard) [TAM]; 2, Victoria, Texas, Mar. 21, 27 (E. A. Schwarz) [USNM].

Remarks: This species is easily recognized by the two fuscous vittae on the elytra, one of which is narrow, along suture, the other being broad and below sides of disk. In the antennal structure, it approaches *alpha* but the pronotum is somewhat broader, with the lateral tubercles only feebly armed.

Sternidius vittatus Dillon, spec. nov.

Male: Ferrugineous, elytra bright testaceous; rather sparsely covered with ashy pubescence, tinged with brownish on pronotal disk and with fulvous on basal half of elytra as well as on the apical region of the latter. Head, body beneath, femora, and first five antennal segments coarsely mottled with brown. Pronotum with three indistinct, fuscous maculae. Elytra with a narrow, dark brown margin around scutellum and a vitta of the same color running along suture to behind middle (gradually widening posteriorly) where it joins a post-median fascia, the latter placed at an angle of 35°–45° with suture, strongly interrupted laterally but not angulated, paralleled at apical fourth by an indistinct, broad, dark fascia, usually more prominent toward sides; on sides behind humeri with a mere suggestion of a fuscous cloud. Tibiae broadly annulate with fuscous on apical two-fifths (indistinctly and narrowly so at basal third) and tarsi entirely fuscous. Antennae narrowly and indistinctly fuscous annulate on apices of segments from third.

Head distinctly punctate in the rather shallow median impression of vertex; front one-fourth again as wide as high, sides somewhat narrowed between eyes, more strongly so below, strongly convex, continuing (in profile) the arc of the vertex; eyes with lower lobe distinctly transverse, scarcely taller than gena, upper lobe two-fifths as wide as interocular space. Pronotum one-half again as wide across lateral tubercles as long, sides gradually tapering apically, strongly constricted at base; lateral tubercle not prominent, armed with a quite short but distinct tooth; disk feebly trituberculate, finely, densely punctate; basal sulcus broad, deeply impressed. Elytra with basal gibbosity moderately prominent; disk entirely covered with rather coarse, deep, fairly close-set punctures, and disk with four feeble costae which bear a number of low, finely tufted tubercles; apices rather narrowly, obliquely truncate, sometimes emarginately so, the angles more or less prominent. Femora very strongly clavate. the metafemora subequal in this respect to the mesofemora, attaining apex of abdomen. Fifth sternite one-half again as long as fourth. Antennae about one and three-fifths as long as body, not fimbriate beneath; scape extending to basal two-fifths of pronotum; third segment one-fifth longer than first; fourth as long as third; rest gradually decreasing in length.

Female: Like male except femora not strongly clavate, metafemora much more slender than mesofemora, feebly surpassing apex of fourth sternite. Fifth sternite subequal to third and fourth combined. Antennae two-fifths longer than body, fourth segment a little shorter than third.

Length 4.8–5.2 mm.; width 1.4–1.7 mm.

Holotype: Male, allotype female, and two paratypes: Lucedale, Mississippi, Mar. 29, 1932 (one paratype Apr. 18, 1930) (H. Dietrich) [CU].

Remarks: In having a fuscous sutural vitta, this species resembles *suturalis*, from which it differs in lacking the lateral vitta on the elytra, in having the lower ocular lobe transverse, the pronotum less strongly transverse, and the lateral tubercles more distinctly dentate.

Incertae Sedis

Leiopus setipes Casey, 1891, Ann. New York Acad. Sci., 6: 48.

"Moderately robust, convex, piceo-testaceous, densely clothed with dark luteous pubescence, devoid of fasciculate tufts of coarser hairs, and with an anteriorly angulate white fascia behind the middle, also a very feebly defined paler oblique line on each elytron near the apex. Head extremely minutely, densely punctate when denuded; eyes separated above by a distance which is scarcely more than one-half as great as in *wilti;* antennae slender, two-fifths longer than the body, nearly as in *wilti*. Prothorax one-half wider than long, four-fifths as wide as the elytra,

rather finely and closely punctate, the pubescence very indefinitely variegated; lateral spine short but not at all blunt, just behind middle, nearly as in *wilti* but slightly more anterior in position. Elytra three-fourths longer than wide; sides nearly parallel in basal two-thirds, then oblique to the apex, each elytron narrowly and obliquely truncate; disk coarsely, deeply punctate when denuded, each elytron with a large lateral blackish semi-denuded spot, and three costiform lines along which the pubescence is more prominent, the recumbent pubescence unusually long; erect hairs short and very sparse. Under surface dark plumbeous, densely, pubescent. Legs rather short and stout, throughout nearly as in *wilti*, but with long flying hairs on the tibiae, especially pronounced on the posterior. Length 7.0 mm.; width 2.8 mm.

"Texas (El Paso). Mr. Dunn.

"This species in general appearance is intermediate between *alpha* and *wilti*, but is not closely related to any other form, the long flying hairs of the tibiae being a very unusual character in *Leiopus*. In the present arrangement of the species it may be placed just after *punctatus*."

Pseudastylopsis Dillon, gen. nov.

Moderately small or moderate-sized, subconvex forms, with prothorax quite cylindrical. Head nearly impunctate above; front densely punctulate, feebly convex, forming a slight angle with mouthparts, widest below lower angle of eye, one-third to two-fifths wider than high, strongly narrowing to mouth and distinctly narrowing between eyes; eyes separated above by twice the width of an upper lobe, lower lobe subequal to gena in height. Pronotum quite cylindrical, sides subparallel, widest just behind middle, not quite half again as wide as long, lateral tubercles small, not or scarcely equalling median discal tubercle in this respect; disk entirely, distinctly punctate, with five or seven tubercles, the central one strongly prominent. Elytra distinctly punctate to apices, usually with prominent costae, always tuberculate or with scattered, serrate tufts; apices not prolonged, subtruncate or separately rounded. Prosternal process one-sixth as broad as a procoxal cavity; mesosternal process about two-thirds as broad as a mesocoxal cavity, expanded apically; fifth sternite in male one and a half times as long as fourth, in female as long as third and fourth combined. Antennae slightly longer than body in female, one-fourth longer in male; scape extending to just behind middle of pronotum, prominent at apex on ventral side; third segment at least one-fifth longer than first; fourth at least subequal to first; fifth two-thirds or more, and sixth and one-half or more, as long as first; rest gradually shorter.

Genotype: Leptostylus nebulosus Horn.

Remarks: With *Astylopsis*, its very close ally, this genus forms a small group, isolated from other North American genera. From *Astylopsis* it differs mainly in having the prosternal process only one-sixth as broad as a procoxal cavity and the third segment of antennae longer than first and the fourth subequal to or longer than first. In addition, the front is narrower, and the pronotum is more cylindrical with the median discal tubercle more pronounced.

KEY TO SPECIES

Pronotum largely cinereous pubescent, without a central area set off by black vittae; tarsi cinereous at base ..... **nebulosus**

Pronotum mostly ochraceous pubescent, with a central area bordered by black vittae or bars; tarsi entirely black ..... **pini**

Pseudastylopsis nebulosus (Horn)

Leptostylus nebulosus Horn, 1880, Trans. Amer. Ent. Soc., 8: 122. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc., 23: 118.

Male: Largely piceous, covered rather densely with ashy pubescence, often irregularly clouded with dingy brown. Head above, body beneath, legs, and first seven segments of antennae mottled with fuscous or brown. Pronotum fuscous maculate on each of the discal tubercles. Scutellum fuscous, except for a median macula of cinereous. Elytra with a fuscous streak near scutellum reaching to near basal fourth of suture, often joined by a short, fuscous, transverse line at basal sixth, behind this line the integument is quite pale and the pubescence is often tinged with tawny; just before middle at suture a broad cinereous band extends obliquely posterolaterad to sides, where it becomes tinged with fulvous; the entire area behind this band is irregularly variegated with brown, fuscous, and ashy; the costae and sutural margin bear short tufts of fuscous hairs. Tibiae fuscous-annulate at basal third and broadly so at apex; tarsi with last two segments and the apex of the second segment fuscous, rest cinereous. Antennae with apices of all segments fuscous annulate.

Entire upper surface minutely alutaceous. Head impunctate or with two or more punctures above; front flat, widest below lower angle of eye, one-third wider than high, strongly narrowed to mouth, feebly so between eyes; eye with lower lobe subquadrate, one-fifth again as tall as gena. Pronotum broadest slightly behind middle, not quite one-half again as wide as long, lateral tubercles narrow but prominent, subacute; disk with five prominent tubercles, two before apex, three just behind middle, often as prominent as lateral tubercles, entire surface finely, rather densely punctate, and with a row of coarser punctures in basal sulcus. Elytra with basal gibbosity feeble, somewhat accentuated by a broad, oblique impression behind it; disk with four prominent costae, moderately finely and

rather densely punctate, punctures gradually becoming finer to apex; apices separately rounded or subtruncate. Prosternal process narrow, about one-sixth as broad as a procoxal cavity; mesosternal process nearly half as broad as a mesocoxal cavity; fifth sternite one and one-half times as long as fourth, broadly emarginate at middle. Antennae one-fourth again as long as body, slender; scape attaining or surpassing middle of pronotum; third segment nearly one-fourth longer than first; fourth very feebly longer than first; fifth one-fifth shorter, and sixth one-third shorter, than first; rest feebly diminishing in length.

Female: As in male, but fifth sternite as long as third and fourth together, apex subtruncate; and the antennae only slightly longer than the body.

Length 9.5–12.5 mm.; width 3.6–4.7 mm.

Type Locality: Western Nevada.

Distribution: Nevada and California. California: 1, Trinity Co., June 12, 1934 [CAS]; 1, Pohono Trail, June 15, 1931 [CAS]; 2, Martins Springs, Lassen Co, August 5, 1922 [CAS]; 4, Giant Forest, Tulare Co. [CAS;KU]; 1, Pine Crest [CAS]; 6, Bass Lake, June 26, *Abies concolor* (E. G. Linsley) [CAS].

Remarks: When specimens from intervening areas of the two forms concerned have been collected in sufficient quantities, this species and *pini* may prove to be distinct only as subspecies.

Pseudastylopsis pini (Schaeffer)

Leptostylus pini Schaeffer, 1905, Sci. Bull. Brooklyn Inst. Mus. Sci., 1: 165.

Astylopsis pini (Schaeffer). Leng, 1920, Cat. Col. N. Am., p. 282.

Female: Black, rather densely covered with short, shaggy, cinereous pubescence, strongly varied or mottled with black and dark brown, especially on head, antennae, scutellum, body beneath, and legs. Pronotum dark brown, fulvous pubescence; medially with a patch of rather dingy fulvous, the sides sparsely varied with cinereous; disk on each side of middle with two longitudinal, black bars, one apically, the other basally, and with a median blackish vitta extending from apex to central tubercle, from which extends on each side an oblique blackish band to the basal bars. Elytra cinereous pubescent at base near scutellum, an irregular ashy band extending from before middle of suture obliquely to sides (interrupted by three fulvous vittae), and with scattered ashy patches apically; marked with black pubescence on remainder of base, in a V-shaped band beginning and ending at basal quarter, and in a common diamond-shaped marking (enclosing a cinereous patch) extending from middle to apical quarter, and with scattered serriform, black tufts; remainder bright fulvous pubescent. Tibiae annulate with blackish at extreme base, at basal third, and at apex; tarsi entirely black. Antennae reddish brown (except the piceous scape), cinereous pubescent, mottled with brownish and annulated with fuscous on apices of all segments; second and last segments entirely fuscous pubescent.

Entire upper surface minutely rugulose and finely punctulate. Head often with a few punctures on vertex between eyes; front minutely densely punctate, widest below lower angle of eye, two-fifths wider than high, strongly narrowed to mouth, a little more feebly so between eyes; eyes with lower lobe subquadrate, nearly as tall as gena. Pronotum nearly half again as wide as long, sides subparallel, feebly widening towards apex, lateral tubercles feeble, obtusely rounded; disk rather densely, moderately coarsely punctate, visibly more densely so on median patch, with seven rounded tubercles, four anteriorly, of which the two middle ones are more conspicuous, and three behind middle, the central one very prominent, exceeding the lateral tubercles in size, the others quite minute. Elytra more finely and more sparsely punctate than pronotum, and with scattered prominent tubercles, especially on basal gibbosity, which is rather prominent; disk with four costae, prominent in part; apices separately rounded or subtruncate. Prosternal process about one-sixth as wide as a procoxal cavity; mesosternal process about two-thirds as broad as a mesocoxal cavity; fifth sternite as long as third and fourth combined. Antennae only slightly longer than body; scape extending slightly behind middle of pronotum; third segment about one-fifth longer than first; fourth subequal to first; fifth two-thirds, and sixth about half, as long as first; rest gradually shorter.

Length 8–10.5 mm.; width 3–4 mm.

Type locality: Carr's Peak, Huachuca Mountains, Arizona.

Distribution: Arizona and New Mexico. Arizona: 2, Carr Canyon, Huachuca Mts., June 6, 1923 (E. G. Linsley) [CAS]. New Mexico: 1, Mescalera Reservation, August [CU].

Eutrichillus Bates

Eutrichillus Bates, 1885, Biol. Centr.-Amer. Col. V, p. 397.
Lepturgoides Schaeffer, 1905, Sci. Bull. Brooklyn Inst. Arts Sci. 1: 166. [new syn.]

Moderately small, elongate, subdepressed. Head with vertex strongly declivous, rather deeply impressed behind antennal tubercles, impunctate, with long flying hairs around eye and on gena; front one-seventh to one-fourth again as wide as high, distinctly narrowed between and below eyes, feebly convex; eye with lower lobe oblong, erect, ranging from slightly shorter than gena to one-half again as tall as it, upper lobe distinctly wider than isthmus, equal to about half the width of interocular space (except in *canescens* where it is only slightly more than one-fourth that width); antennal tubercles not very prominent, strongly divergent apically. Pronotum from one-half to

two-thirds again as wide across lateral tubercles as long; sides narrowed gradually to apex, constricted at base; lateral tubercles small, placed near basal third, armed with an acute, retrorse tooth; basal sulcus distinct, continuing behind lateral tubercles; disk with two small tubercles near apex and often a third low one medially, surface punctate, especially basally. Elytra each with a small, rather prominent, crested basal gibbosity and usually with two other tufted crests near middle; disk with four costae, sometimes distinct only apically, which bear a number of small tufted tubercles, each of which is provided with a long flying hair (in the genotype there are, in addition, hairs arising from punctures), surface entirely, moderately densely punctate; apices obliquely truncate at suture, the angles not prominent; humeri simple. Prosternal process quite narrow, sublinear; mesosternal process about twice as broad as that of prosternum, tapering. Fifth sternite subequal to fourth in male, equal (or nearly so) to third and fourth together in female. Femora strongly clavate, metafemora more slender but still distinctly clavate, attaining apex of fourth sternite in male, of third in female, as a rule; metatarsi with first segment longer than rest together, first segment successively proportionately shorter in meso- and protarsi (except in *canescens*, where it is shorter than rest together and longer than next two together on all legs). Antennae one-half or more again as long as body, with long, scattered fringing hairs beneath, at least on basal three segments; scape somewhat clavate, attaining basal sixth of pronotum; third segment one-tenth longer than scape (except in *neomexicanus*); fourth shorter than third (with the same exception); rest gradually diminishing in length.

Genotypes: Eleothinus comus Bates [*Eutrichillus*]; *Lepturgoides pini* Schaeffer (*Lepturgoides*), each by monotypy.

Remarks: This genus is quite closely related to *Ceratographis*, but differs in having the front transverse instead of quadrate and the pronotal disk distinctly tuberculate, in lacking flying hairs except on legs and elytra, and in the shorter legs and ovipositor.

E. comus is quite similar to *E. pini* in general appearance, but the elytra are more strongly hirsute and the hairs are of equal length throughout. Other differences exist in the shape of the lower ocular lobe, the antennal formula, and the disposition and form of the elytral crests.

KEY TO SPECIES

1. Eye with lower lobe one-half again as tall as gena; antennae with fourth segment longer than third, which is also shorter than first . . . . . **neomexicanus**
   Eye with lower lobe never taller than gena; antennae with third segment longer than first as well as fourth 2
2. Eye with upper lobe about one-fourth as wide as upper interocular space; metatarsi with first segment shorter than rest combined . . . . . **canescens**
   Eye with upper lobe about one-half as wide as interocular space; metatarsal first segment longer than rest combined . . . . . **pini**

Eutrichillus pini (Schaeffer)

Lepturgoides pini Schaeffer, 1905, Sci. Bull. Brooklyn Inst. Arts. Sci., 1: 166.

Male: Dark reddish brown, rather densely covered with white or ashy pubescence. Head on vertex with a transverse, fuscous macula medially and another around base of each antennal tubercle; front often clouded with dull brown and sometimes with one or two fuscous maculae along median line. Pronotum with three fuscous vittae on disk, one medially on basal half, and a biangulated one each side of middle, usually entire, but sometimes more or less interrupted or broken into maculae; just below lateral margin a similar entire vitta which crosses the lower half of the lateral tubercle. Scutellum fuscous, sometimes with a patch of whitish at middle of base. Elytra indistinctly clouded with fuscous basally, on deflexed sides a broad fuscous fascia extending from humerus to basal third, thence traversing disk obliquely to just before middle of suture and continuing posteriorly to connect broadly with a shorter similar fascia, the latter beginning behind middle of side of disk and not attaining side margin; near apical fourth a third fuscous fascia, narrower than the others and often interrupted to form two maculae; fasciae frequently displaying some evidence of three white longitudinal lines which are interrupted by small, blackish tufts. Body beneath and legs sparsely whitish pubescent; femora irregularly biannulate with fuscous near apices; tibiae each with two elongate, fuscous maculae, one near base, the other before apex; tarsi fuscous, first segment broadly, second one narrowly, annulate with cinereous at base. Antennae fuscous pubescent; scape annulate with white at middle and at apex; segments three to seven white annulate narrowly on bases and more broadly so beyond middle, remaining segments rather broadly annulate with white on bases only.

Head impunctate, rather deeply impressed behind antennal tubercles; front one-seventh broader than tall, feebly narrowed between and below eyes, two or three suberect hairs near ocular margin; eye with lower lobe oblong, erect, not quite equal to gena in height. Pronotum about three-fifths again as broad across lateral tubercles as long, sides arcuately narrowed on apical half, strongly constricted behind lateral tubercles, which are small, not prominent, armed with a slender, acute spine, which is directed nearly equally posteriorly and laterally; disk with three low tubercles, one medially and one each side close to anterior margin. Elytra with basal gibbosity small, slightly prominent, bearing a short, tufted crest; disk with four costae, more distinct on posterior half, each of which bears

five to seven very small tubercles from each of which arises a single long hair, the hairs shorter caudally; surface densely, rather coarsely punctate, nearly to apex; apices obliquely truncate, the angles not prominent. Pro- and mesosternal processes sublinear; fifth sternite slightly longer than fourth. Metafemora robust, strongly clavate, attaining apex of fourth sternite. Antenna nearly twice as long as body, beneath on first seven segments with sparse, rather short, fringing hairs; scape rather robust, attaining basal fifth of pronotum; third segment one-fifth longer than first; fourth distinctly shorter than third; rest gradually decreasing in length.

Female: Similar to male but fifth sternite one and one-half times as long as fourth; metafemora slender, slightly clavate, reaching not quite to middle of fourth sternite.

Length 6.5–10 mm.; width 2.1–3.2 mm.

Type locality: Carr's Peak, Huachuca Mountains, Arizona.

Distribution: Middle and southern Rocky Mountain States. Colorado: 2, Manitou, June 14–16, 1915, reared from *Pinus edulis* (B. T. Harvey) [USNM]. New Mexico: 3, Las Vegas, Aug. 15 (Barber and Schwarz) [USNM]; 1, White Mt., 10,000 ft., July 25, 1930 (E. R. Tinkham) [CAS].Arizona: 1, no further locality, 9,000 ft. [KU]; 3, Huachuca Mts. (Schaeffer) [LL]; 3, Williams, July 16–20 [USNM]; 1, Bright Angel, July 10 [USNM].

Remarks: This species is distinguished most easily by the double dark fascia at middle and by the erect hairs on elytra diminishing in length posteriorly.

Eutrichillus canescens canescens
Dillon, spec. nov.

Female: Dark ferrugineous brown, femora and antennae testaceous; entirely covered with hoary pubescence, irregularly and indistinctly varied with fulvous on head and pronotum. The latter with a broad brown fascia each side of middle and one less distinct medially on basal half; just below lateral margin an irregular, vague, light brown vitta. Scutellum narrowly margined with blackish. Elytra each with a light brown marking which extends along side of disk from near middle nearly to apex, where it curves mesially to the suture, accentuated at apical two-fifths with three prominent fuscous vittae (the median one of which is longest) and continued forward along side margins to humerus by a fuscous vitta which commences posteriorly at apical fourth; disk very sparsely sprinkled with blackish tufts and with several vague traces of the white lines found in related species. Tibiae each with two elongate, dark brown maculae; tarsi fulvous pubescent, first segment narrowly annulate with hoary. Antennae sparsely fuscous pubescent, third to fifth segments narrowly white annulate at base and more broadly so beyond middle, remaining segments white pubescent on basal halves.

Upper surface minutely alutaceous. Head impunctate, above strongly and broadly impressed behind antennal tubercles; front one-fourth again as wide as tall, distinctly narrowed between and below eyes, feebly convex; eye with lower lobe oblong, erect, not quite so tall as gena. Pronotum two-thirds again as wide across lateral tubercles as long; sides arcuately narrowed to apex, strongly and rather narrowly constricted at base; lateral tubercles small, not prominent, armed with an acute, strongly retrorse tooth; disk with three small, feebly elevated tubercles, one each side of middle close to anterior margin, the other behind center, surface sparsely, rather coarsely punctate, the punctures in basal sulcus denser and forming two transverse series. Elytra with basal gibbosity rather small, somewhat prominent, with a tufted crest that is scarcely larger than the small tufted tubercles widely dispersed over disk, the crest and tubercles provided each with a long, erect hair; disk rather coarsely, not densely punctate to apex, behind middle an elongate brush of hair (forming one of the fuscous vittae); apices obliquely truncate. Fifth sternite as long as third and fourth together. Metafemora gradually but not strongly clavate, attaining apex of third sternite. Antennae defective, the last four segments wanting, sixth attaining elytral apex, beneath with three or four fringing hairs on first three segments; scape attaining basal sixth of pronotum; third segment one-tenth longer than first; rest gradually decreasing in length.

Length 6.7–7.2 mm.; width 2.2–2.4 mm.

Holotype: Female; Mescalera Reservation, New Mexico, Aug., 1927 (Chamberlain) [CU].

Paratype: 1; same data as type [CU].

Remarks: In this species the whole basal half of each elytron is entirely whitish pubescent, and the erect hairs of that same organ are of equal length throughout, not shorter apically.

Eutrichillus canescens nelsoni
Dillon, subspec. nov.

Male: Very similar to the nymotype but integument fuscous, except middle of pronotal disk which is bright reddish brown. Maculation and elytral tufts composed of black pubescence, sharply contrasting with the whitish pubescence covering rest of the surface. Elytral tufts more prominent and more numerous, each row consisting of seven or more tufts (instead of three or four as in the typical race). Antennae similar to body in color, with third to sixth segments distinctly whitish biannulate. Erect hairs on elytra and on tibiae much denser, as are also to a lesser degree the fringing hairs of the antennae; those on the elytra also are not quite so long basally and are more distinctly abbreviated towards apex.

Length 8.7 mm.; width 2.9 mm.

Holotype: Male; Prescott, Arizona, Aug. 21, 1953 (G. H. Nelson) [author's collection].

Paratype: Male; Davis Mts., Texas, June 9, 1954 (D. J. & J. N. Knull) [J. N. Knull].

Remarks: It is a pleasure to name this attractive subspecies after its collector, who has very kindly contributed it for the author's collection.

Eutrichillus neomexicanus Champlain and Knull

Lepturges neomexicanus Champlain and Knull, 1925, Ann. Ent. Soc. Amer., 18: 470.

Female: Piceous, rather densely covered with white pubescence, coarsely variegated with pale brown and fuscous. Head above with a poorly defined fuscous macula each side of middle; front similarly marked below antennal tubercles, which also are irregularly fuscous maculate. Pronotum just behind apical margin with an oblique fuscous macula each side of middle; disk often clouded with brown medially; below lateral tubercles a broad, entire, fuscous vitta. Scutellum broadly fuscous marginate. Elytra with a large, common, fuscous cloud around scutellum, a large, subquadrate, fuscous macula laterally behind humerus and a similar but darker one behind middle laterally; thus the white pubescence is reduced essentially to a lateral premedian patch, another patch suturally behind basal third, an irregular apical area, and four longitudinal lines which are much interrupted by tufts of fuscous hairs. Body beneath broadly tinged with brownish each side. Femora clouded with brown medially, before apex with a broad fuscous annulus, interrupted beneath; tibiae with entire basal halves and an annulus near base, fuscous; tarsi entirely fuscous. Antennae with scape piceous, white pubescent, with a fuscous annulus at apex; remaining segments dark reddish brown, with fuscous pubescence, annulate on bases with white.

Upper surface minutely alutaceous. Head glabrous on occiput, impunctate, medially rather deeply impressed behind antennal tubercles; front about one-fifth wider than high, somewhat narrowed between and below eyes; with several long flying hairs along ocular margin; eye with lower lobe oblong, suberect, one-half again as tall as gena. Pronotum one-half again as wide across lateral tubercles as long; sides gradually narrowing anteriorly, strongly constricted behind lateral tubercles, which are moderate in size, not prominent, armed at basal third with a long acute tooth which is directed equally posteriorly and laterally; disk near apical margin with a feeble tubercle each side of middle, basal two-thirds finely punctate, the punctures medially extending to apex, basally becoming coarser and denser. Elytra with basal gibbosity rather prominent, small, at apex with an elongate tufted crest; disk with four more or less distinct costae, each provided with a number of low crested tubercles which bear a single long flying hair, surface rather densely, finely punctate to apex; apices broadly, slightly obliquely truncate. Fifth abdominal sternite subequal to the two preceding combined. Metafemora not attaining apex of third sternite. Antennae about one-half again as long as body, beneath with sparse, long fringing hairs on first four segments; scape slender, attaining basal third of pronotum; third segment one-seventh longer than first; fourth equal to, or longer than, third; rest gradually decreasing in length.

Length 8–10 mm. (excluding ovipositor), 9–11.5 mm. (including ovipositor); width 2.6–3 mm.

Type locality: Jemez Springs, New Mexico.

Distribution: Arizona and New Mexico. Arizona: 3, Williams, June 1–July 24 (Barber and Schwarz) [USNM].

Remarks: This species is distinguished by its elongate form, by the erect hairs being present on the head and elytra, but absent from legs and antennae, by the four white, interrupted lines on elytra, and by the antennae being white annulate only on bases of segments.

Ceratographis Gahan

Graphisurus Kirby. Horn, 1880, Trans. Amer. Ent. Soc. 8: 128 [misdet.].

Ceratographis Gahan, 1888, Trans, Amer. Ent. Soc., 15: 300. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 130, 131. Wickham, 1897. Can. Ent., 29: 203. Blatchley, 1910, Col. Ind., p. 1070. Knull, 1946, Bull. Ohio Biol. Surv., 39: 255.

Moderately small, subdepressed, rather sparsely pubescent forms. Head with front subplanate in female, slightly convex in male, about one-fourth wider than high, finely punctate, somewhat narrowed between eyes, much more strongly so below eyes; eyes with lower lobe erect, oblong-ovate, one-fourth again as tall as gena, upper lobes separated by about twice their width, isthmus about three rows of facets broad. Pronotum more than one-half again as wide across tubercles as long, sides irregular, oblique apically to near middle, feebly constricted behind lateral tubercles, which are rather narrow but prominent, armed with a thick, subacute, rather long, retrorse tooth, and placed at basal third; disk without distinct tubercles as a rule, rarely with an obsolete median or two obsolete apical ones, uniformly punctate throughout. Elytra somewhat flattened above; disk with two scarcely discernable costae, and another equally feeble costa at side, densely, rather coarsely punctate, the punctures gradually finer apically; basal gibbosity slightly prominent; surface ornamented with several tufts of hair and provided with numerous long, erect, flying hairs, which are not arranged in distinct rows; apices separately rounded. Legs moderately long, becoming successively longer posteriorly; femora rather robust, successively slightly slenderer from front to rear pair in male, much more slender in female, with a few scattered flying hairs in both sexes; all tibiae with very numerous, long, erect hairs; tarsi with a few

shorter flying hairs, segments elongate, protarsi with first segment one-half again as long as second, mesotarsi with first segment as long as rest together, and metatarsi with the same segment even longer. Antennae one and one-half (female) to two times (male) as long as body, sparsely fimbriate beneath to fifth segment; scape with numerous, long, flying hairs on all sides, extending to basal fifth of pronotum, slender, not deflexed beneath at apex; third segment arcuate, slightly longer than first; fourth as long as first, and rest very gradually decreasing in length in female, in male fourth and following subequal to third. Prosternal process about one-eighth (or less) as broad as a procoxal cavity; mesosternal process tapering posteriorly, about one-sixth as broad as a mesocoxal cavity. Fifth sternite in male scarcely longer than fourth, broadly triangularly emarginate at apex; in female, nearly as long as rest combined, produced into an ovipositor, apex narrowly notched.

Genotype: Liopus biguttatus Le Conte, by monotypy.

Remarks: From related genera with similarly narrow pro- and mesosternal processes and with long flying hairs on the elytra, this genus is distinguished by having similar hairs on the tibiae and scape. Moreover, the lower ocular lobe is erect, slightly exceeding gena in height, while the upper lobes are separated more narrowly than elsewhere. The antennae have the scape not deflexed at apex, the third segment longer than the first, the rest subequal to third in male, while the pronotal disk is devoid of tubercles and is uniformly punctate throughout.

Ceratographis biguttata (LeConte)

(Fig. 1)

Liopius biguttatus LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia (2)2: 172.

Ceratographis biguttata (LeConte). Gahan, 1888, Trans. Amer. Ent. Soc., 15: 300. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 131. Wickham, 1898, Can. Ent. 30: 39. Blatchley, 1910, Col. Ind., p. 1079. Knull, 1946, Bull. Ohio Biol. Surv., 39: 255, pl. 24, f. 97.

Graphisurus pusillus Kirby. Horn, 1880, Trans. Amer. Ent. Soc., 8: 129. [misdet.].

Various shades of rufo-ferruginous, pronotum and often legs somewhat paler or more yellowish; sparsely covered with short, cinereous pubescence, which is often broadly tinged with brownish on the pronotal and elytral disks. Elytra usually with suture and the discal costae tinged with white; disk with three tufts of fuscous hairs, one near middle basally, and two behind middle, the inner one set slightly posterior to the other and often forming with it a short, oblique streak. Tibiae and tarsi fuscous, the former narrowly annulate with cinereous at base and medially; tarsi with first two segments annulate basally with cinereous. Antennae largely fuscous or brownish pubescent; scape on inner surface sparsely cinereous pubescent; remaining segments narrowly annulate with denser, ashy pubescence basally.

Entire upper surface minutely alutaceous. Head with vertex subdepressed between eyes, scarcely tumid behind; front rather densely, very finely punctate, near eye with six to eight coarse punctures which bear long, flying hairs. Pronotal disk rather finely, fairly densely punctate, the punctures slightly coarser near base but not linearly arranged there. Elytra coarsely, densely punctate, the punctures much finer on apical half.

Length 6.5–8 mm.; width 2.2–2.5 mm.

Type locality: New York.

Distribution: Throughout eastern North America as far west as Michigan. Virginia: 1, Richmond, June, 1951 [USNM]. North Carolina: 2, Asheville, Aug. [USNM]; 5, Fryon, Mar., Apr., bred from pine (W. F. Fiske) [USNM]. Wisconsin: 1, Port Edwards, Wood Co., July 8, 1949 (R. D. Shanefelt) [WU].

Canonura Casey

Graphisurus (*Canonura*) Casey, 1913, Mem. Col., IV, p. 335.

Moderately slender, elongate, large beetles, having head punctate above; front impunctate as a rule, ranging from one-eighth to one-fourth broader than high, feebly narrowed between eyes, much more strongly so below eyes to mouth; eye with lower lobe quadrangular, erect, ranging from subequal in height to gena in *princeps* to two-thirds or more again as tall as gena in *leechi*. Pronotum cylindrical, two-thirds or more again as wide across lateral tubercles as long; sides irregular, wider before middle than at base; lateral tubercles small but rather prominent, placed just behind middle, armed at apex with a tooth which is acute and directed feebly posteriorly except in *spectabilis;* disk entirely transversely tumid except at extreme base and apex, each side with three small tubercles arranged in an inverted triangle, entire surface fairly densely covered with moderately coarse punctures; transverse sulci poorly defined. Elytra subcylindrical, sides slightly tapering and distinctly deflexed to apex, each with two discal and one sublateral costa, variable in prominence, the middle one usually most distinct, at least on apical half; basal gibbosity rather small, prominent in *spectabilis* but not in the other species; disk at base densely punctate, suddenly sparsely so behind middle, the punctures at extreme base and on humeri bearing granules; apices separately broadly rounded or subtruncate. Prosternal process about one-fifth as broad as a procoxal cavity; mesosternal process nearly one-half as broad as a mesocoxal cavity. Fifth sternite in male from one-fourth to one-half again as long as fourth, emarginate at apex, in female as long as second to fourth combined, deeply emarginate at apex; ovipositor strongly extended. Legs successively longer posteriorly, the hind pair not markedly longer than the

middle; femora robust, pedunculate at base, apical half rather strongly capitate; protarsi with first segment one-sixth shorter than next two together, mesotarsi with this same segment scarcely longer than next two together, and metatarsi with first one-fifth longer than all remaining segments combined; procoxal and mesocoxal cavities distinctly though briefly angulate at sides. Antennae in male three and one-half to four times as long as body, in female about two and one-fourth times as long as body, extremely densely fimbriate beneath on first five segments; scape reaching to about the basal third of pronotum, slender, feebly clavate apically, not produced downwards at apex; in male third segment from one-third to one-half again as long as first, sometimes in *leechi* somewhat thickened at apex, straight; fourth usually more strongly thickened at apex than third and somewhat longer than that segment (in *leechi* slightly shorter than third); fifth bearing a strong nodule at apex, longer or shorter than fourth in the several species; sixth and seventh variable in length, rest successively longer; in female segments all simple, third to eleventh subequal, each one-fourth longer than first.

Genotype: *Aedilis spectabilis* LeConte, herewith designated.

Remarks: While closely related to *Tylocerina*, this genus differs from the latter in having the entire base of elytra granulate-punctate, in the elytral sides being deflexed, at least slightly, to apex, in the elytral punctures reaching nearly to apex, in the more slender, subcylindrical form of the body, in the sculpturing and form of the pronotum, and in the male having the fifth antennal segment nodulose instead of the fourth.

KEY TO SPECIES

1. Body beneath with large, bright fulvous maculae or areas laterally on each segment of thorax; pronotum each side with a large, whitish patch enclosing several brown points; elytra very finely, sparsely punctate, the punctures at base bearing fine granules; antennal segments slender.... **spectabilis**
   Body beneath entirely whitish pubescent; pronotum without a large, whitish lateral patch; elytra rather coarsely punctate; antennal segments more robust..... 2
2. Pronotum with a transverse subapical row of four fulvescent maculae; elytra irregularly tinged with fulvous, the dark markings forming well defined bands..... **princeps**
   Pronotum with only two whitish maculae preapically; elytra not at all marked with fulvous, the dark markings confused, not forming well defined bands..... **leechi**

Canonura spectabilis (LeConte)

(Fig. 6)

Aedilis spectabilis LeConte, 1854, Proc. Acad. Nat. Sci. Philadelphia, 7: 82; 1859, Surv. Colo., Kans. and New Mex., p. 22, pl. 2, fig. 16.

Graphisurus (*Canonura*) *spectabilis* (LeConte). Casey, 1913, Mem. Col. IV, p. 339.

Male: Ferrugineous, rather sparsely covered with short, white pubescence, which is denser around eyes and on sides of elytra. Head tinged with fulvous on front. Pronotum broadly clouded with dull brownish, on middle of each side an irregular, dense, white (sometimes partially tinged with yellowish) tomentose area which encloses several points of deep brown and which is outlined with this latter color. Scutellum dull cinereous pubescent, narrowly touched with fulvous each side and with whitish at apex. Elytra each with four dark brown, irregular fasciae, all oblique except the basal ones: first at extreme base, usually not covering humerus and often joining a rather large, similarly colored, subsutural macula; second extremely sinuous, at basal two-fifths; third just behind middle, usually in part shaded with dull fulvous; and fourth strongly angulated, at apical fifth; rest of disk near base with a few dark brown, rounded dots. Body beneath and legs more densely white pubescent than upper surface; thorax laterally at middle of each segment with a large, golden fulvous macula; abdomen nearly glabrous, thinly dull brownish pubescent each side, without rounded dark dots; femora with three dark brown annulae, a broad one on base, a narrower one just beyond middle, and a less distinct one before apex; tibiae with a broken annulus at apical and basal thirds; tarsi dark brown pubescent, first segment broadly white annulate at base. Antennae rather thinly clothed with ashy-white pubescence; second segment dark brown pubescent and first, third, fourth, and sometimes fifth segments broadly annulate with the same color above.

Entire upper surface minutely alutaceous. Head above moderately finely, sparsely punctate and with several punctures behind lower lobe of eye; front impunctate; eye with lower lobe erect, slightly exceeding gena in height. Pronotum two-thirds again as wide across lateral tubercles as long, wider before middle than at base, constricted at extreme apex, sides irregular; lateral tubercle small, prominent, irregular, armed with a short, obtuse spine; disk densely covered with moderate-sized punctures, especially at middle and across base, entirely tumid, at middle with a small tubercle and each side before middle with a larger but less pronounced tubercle. Elytra with basal fourth densely covered with fine granulate punctures which extend along sides nearly to middle, rest of surface with sparse, simple, fine punctures which are wanting on apical fifth; basal gibbosity sometimes prominent; apices separately obliquely, angularly rounded to suture. Prosternal process one-fifth as wide as a procoxal cavity; mesosternal process nearly one-half as broad as a mesocoxal cavity; fifth sternite one-third again as long as fourth, deeply emarginate at apex. Antennae slender, four times as long as body, the fifth segment strongly surpassing elytral apex, very densely, briefly fimbriate beneath to the end of the fifth segment; scape at-

taining basal third of pronotum, slender, not produced beneath at apex; third segment two-fifths longer than first, feebly enlarged at apex; fourth, fifth, and sixth successively longer than third, the fourth slightly enlarged at apex, the fifth with a strong tufted nodule there; seventh equal to sixth, eighth much longer, ninth and tenth gradually longer, and eleventh greatly elongate.

Length 18–22 mm.; width 5.2–6.5 mm.

Type locality: Fort Union, New Mexico.

Distribution: Montana and South Dakota south through the Rocky Mountain states to Mexico. Montana: 1, Lame Deer (G. Vogt) [USNM]. South Dakota: 1, Elmore (W. F. Fiske) [USNM]. Colorado: 1, no further date [CAS]; 2, Larkspur, Aug. 10 (G. Hofer) [USNM]; 3, Waldo Canon, July-Sept. (G. Hofer) [USNM]. New Mexico: 1, no further data [USNM]; 1, Porvenir (A. Fenyes) [CAS]; 1, Mecks, Apr. 22 [USNM]. Arizona: 4, Chiricahua Mts., June (Hubbard & Schwarz) [USNM]; 1, Williams, June [USNM]; 2, Flagstaff, July, Aug. [USNM].

Breeds in various species of pine, including *Pinus scopulorum* and *P. ponderosa*.

Remarks: This species has in the past, been much misunderstood, probably in part because of its rarity; its name has most frequently been applied to its more common Pacific Coast congener, which it in no way closely resembles. From all the other members of the genus, it is distinct in having slender antennae and in being finely punctate, especially on the elytra. The pronotum has a large whitish or yellowish plaga on each side, enclosing some dark brown dots, and the under surface of the thorax has on each side of all three of its segments a large, bright fulvous spot. Furthermore, its undersurface is not spreckled with brown dots.

Canonura princeps (Walker)

Eutrypanus princeps Walker, *in* Lord, 1866, Nat. in Brit. Columbia, II, p. 331.

Acanthocinus spectabilis (LeConte). Horn, 1880, Trans. Amer. Ent. Soc. 8: 130. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc., 23: 132 [misdet].

Graphisurus (*Canonura*) *vinctus* Casey, 1913, Mem. Col., IV, p. 340. [new syn.].

Male: Dark ferrugineous, base of head and disk of pronotum darker, and elytra apically usually distinctly paler; entirely covered with a rather sparse, short, hoary gray pubescence and maculate with often longer, denser, fuscous pubescence. Head with an indistinct, broadly V-shaped, fuscous macula on upper portion of front and a short, rather broad, oblique, similarly colored vitta behind middle of eye; front each side above clypeus with a short, arcuate, glabrous streak. Pronotum with disk medially broadly fuscous and with a large, dark macula covering posterior two-thirds of lateral tubercle; disk with four rounded, fulvous maculae arranged in a transverse series across its apical third, these maculae are often indistinctly outlined with fuscous. Scutellum variable, sometimes entirely dusky, sometimes paler ferrugineous, with a dusky macula at middle of each lateral margin; usually with a trace of fulvous pubescence apically. Elytra with four prominent fuscous bands, the first at extreme base, irregularly incised with hoary, the second one broader, at basal fourth, often widened towards suture, usually oblique, broadly interrupted medially with fulvous, third oblique, rather broad, placed just behind middle at sides, extending to apical two-fifths of suture, usually margined or varied with fulvous, and fourth irregular, sometimes broken into large maculae, slightly ascending to suture from apical fifth of sides; disk irregularly, rather thickly sprinkled with rounded, fuscous dots. Body beneath, legs, and antennae more densely covered with longer ashy or hoary pubescence; undersurface laterally and legs strongly mottled with rounded, fuscous dots; femora with two indistinct, dark annulae on apical half; tibiae with a broad, black annulus at apex and a narrower one at basal third; tarsi fuscous, the first two segments maculate above at base with cinereous; antennae with first eight or nine segments broadly annulate with fuscous apically, the scape fuscous mottled on base.

Entire upper surface minutely alutaceous. Head with a few fine punctures behind eye which become a little coarser and more numerous on vertex; front very sparsely, finely punctate, and densely punctulate, near eye with several coarser points, one-eighth wider than long, slightly narrowed below, scarcely so between eyes; eye with lower lobe quadrangular, slightly erect, subequal to gena in height. Pronotum three-fourths again as wide as long, sides wider before middle than at base, narrowly constricted at apex; lateral tubercles small, prominent, irregular, armed with a short, curved acute spine, which is directed distinctly posteriorly; entire disk nearly uniformly covered with moderately coarse punctures, which become a little finer apically at middle, on each side with three small but prominent tubercles arranged in an inverted triangle, the lateralmost of each set being the largest and most distinct. Elytra on basal sixth not densely covered with moderately fine granulate-punctures which do not extend further posteriorly on sides, punctures thence to middle slightly coarser, becoming suddenly finer behind that point and gradually becoming much sparser to apical sixth, from whence they are entirely absent; basal gibbosity somewhat prominent; apices separately broadly rounded or subtruncate. Prosternal process one-fifth as wide as a procoxal cavity; mesosternal process nearly one-half as broad as a mesocoxal cavity; fifth sternite about one-fourth again as long as fourth, broadly emarginate at apex. Antennae more than four times as long as body, the fourth segment nearly

attaining elytral apex, proximal five segments rather robust, and very densely fimbriate beneath, as is the base of the sixth; scape attaining basal two-fifths of pronotum, not produced beneath at apex, very sparsely, finely punctate; third segment one-half again as long as first, distinctly thickened at apex, as is the fourth; fourth, fifth, and sixth successively longer than third, the fifth bearing a large, tufted nodule at apex; seventh feebly shorter than sixth; eighth much longer than preceding, ninth and tenth gradually longer, and eleventh greatly elongated.

Female: As in male but more robust; fifth sternite as long as second to fourth combined, deeply emarginate at apex; ovipositor strongly extended; antennae with sixth segment surpassing elytral apex, segments three to five simple, three to eleven subequal, each one-fourth longer than first.

Length 13.5–24 mm.; width 4.5–7.5 mm.

Type localities: British Columbia [*princeps*]; Siskiyou Co., Calif. [*vinctus*].

Distribution: Pacific Coast, from British Columbia south to California. British Columbia: 6, Midday Valley, Merritt, June 19–Sept. 4, on *Pinus ponderosa* (R. Hopping) [CAS]. Washington: 1, Coulee, Aug., 1932 (A. H. Young) [WSC]; 1, Pullman, July [WSC]. Oregon: 10, Wallowa Mts., Baker Co., July 5–6, 1922 [CAS]. California: 2, Carrville, Trinity Co., June 27, 1913 (Van Dyke) [CAS]. 1, Havilah, Fresno Co., May 8, 1931 (Van Dyke) [CAS]; 3, Huntingdon Lake, Fresno Co. (Blaisdell) [CAS]; 1, San Bernardino Co. [CAS]; 1, Phillips Station, Eldorado Co., July [CAS]; 1, Coultersville, Mariposa Co. [CAS]; 1, Mokel Hills [CAS]; 4, Westwood, Lassen, July 18 (R. Hopping) [CAS]; 1, Norval Flats, Lassen Co. (J. O. Martin) [CAS]; 1, Martin Springs, Lassen Co. [CAS]; 2, McCloud [CAS]; 4, Tallac (A. Fenyes) [CAS]; 3, Yosemite, *Pinus ponderosa* and *P. sabiniana* (E. G. Linsley) [CAS]; 3, Siskiyou Co. (Koebele) [CAS]; 4, Modoc Co. (R. Anderson) [Minn.]; 2, Hetch Hetchy [CU]; 1, Madera Co., Chiquito Creek, July 5, 1920 (H. Dietrich) [CU].

Remarks: The four blackish, irregular bands on the elytron and the four fulvous maculae on the pronotum will serve to distinguish this species from other members of the genus.

Canonura leechi Dillon, spec. nov.

(Fig. 5)

Male: Dark reddish brown to piceous, entirely, rather densely covered with short, hoary gray pubescence and densely mottled with fuscous. Head with a large, blackish macula anteriorly on each antennal tubercle and a smaller, poorly defined one at each side of middle of front above; front without glabrous streaks; behind middle of eye an oblique, fuscous vitta. Pronotum with a broad, irregular, fuscous area at middle, interrupted medially at base and apex with the hoary pubescence and enclosing each side at apical third on irregular creamy ashy macula; sides below, but not on, lateral tubercles with an irregularly shaped, dark macula. Scutellum hoary pubescent, indistinctly tinged with fuscous near basal angles. Elytra with numerous, irregularly shaped and irregularly placed, fuscous maculae which coalesce to a greater or lesser extent, forming an indistinct, poorly defined, oblique band at basal third and another behind middle; the latter band is vaguely interrupted in part with paler brown. Body beneath on sides and femora densely mottled with fuscous, the latter indistinctly biannulate with fuscous on apical half, the preapical annulus quite distinct above and on posterior surface; tibiae with a broad, irregularly incised, fuscous annulus at apex and a narrower one at basal third; tarsi fuscous, first two segments each with a hoary macula above at base. Antennae with first seven segments broadly annulate with fuscous apically, the remaining ones feebly tipped with fuscous at distal ends, the eleventh with a similar preapical macula in addition.

Entire upper surface minutely alutaceous and densely punctulate. Head densely, rather deeply, moderately finely punctate; front impunctate, except for a few fine punctures on its upper portion, one-fourth broader than long; eye with lower lobe quadrangular, erect, about two-thirds again as tall as gena. Pronotum about two-thirds again as wide as long; sides irregular, wider before middle than basally, narrowly constricted at apex; lateral tubercles small, prominent, ending in an acute, recurved tooth; disk uniformly, very densely, moderately finely punctate, each side with three low tubercles, only the mesial one of each set very prominent. Elytra apparently granulate-punctate only on humeri, the granules of the other basal punctures being visible only under high magnification, the punctation similiar to that of pronotum but not quite so dense, behind middle punctures suddenly finer, thence becoming sparser apically but a few attaining apex; apices separately broadly rounded, dehiscent. Prosternal process less than one-fourth as broad as a procoxal cavity; meosternal process less than one-half as broad as a mesocoxal cavity; fifth sternite one-half again as long as fourth, deeply emarginate at apex. Antennae about three and one-half times as long as body, the fifth segment strongly surpassing elytral apex, the first five segments rather robust and very densely, briefly fimbriate beneath; scape attaining basal two-fifths of pronotum; third segment feebly expanded at apex, one-third longer than first; fourth slightly longer, more distinctly expanded apically; fifth shorter than fourth, with a strong nodule at apex; sixth and seventh each subequal to fifth; eighth somewhat longer than seventh; rest successively slightly longer.

Length 21.5 mm.; width 7 mm.

Holotype: Male; Jerome, Arizona (Bruder) [CAS].

Remarks: Although closely related to ***princeps***, this species is quite distinct from it in the sculpturing of the pronotum and elytra, and especially in the antennal formula. In coloration, too, it is distinguished by having two creamy-ashy maculae on the pronotum and by having the elytral pattern strongly confused and lacking all trace of fulvous markings.

This form is named for Dr. Hugh B. Leech from whom the writer has received the above insect and very numerous other favors.

Trichocanonura Dillon, gen. nov.

Moderate-sized, elongate, subdepressed. Head with vertex declivous, deeply impressed behind antennal tubercles, impunctate; front one-half again as broad as tall, distinctly narrowed between eyes, less strongly so below, with erect hairs near eye and on clypeus; eye with lower lobe subquadrate, feebly taller than gena, upper lobes somewhat broader than isthmus, separated by about twice their width; antennal tubercles subcontiguous at base, divergent apically. Pronotum nearly twice as wide across lateral tubercles as long, sides feebly tapering apically, basally broadly constricted; disk coarsely punctate, with two prominent tubercles just behind apex; basal transverse sulcus broad, undulating; lateral tubercles small, placed slightly behind middle. Scutellum rather deeply retuse apically. Elytra elongate, subparallel-sided; basal gibbosity not prominent, bearing a distinct crest of hairs along apex; disk simply punctate, the punctures moderate in size and density, finer apically, evanescent before apex, with four subobsolete costae, becoming more distinct behind middle; entire surface with long, erect setae which are more numerous at base and along costae; apices obliquely truncate, the angles rounded. Prosternal process narrow, less than one-fifth as broad as a procoxal cavity; mesosternal process subequal in width to the preceding. Fifth sternite elongate in female, distinctly longer than the preceding three together, deeply incised at apex. Metatarsal first segment distinctly longer than remaining segments combined. Antennae (female) more than half again as long as body, beneath with a long, not dense fringe to apex; scape slender, attaining basal third of pronotum; second segment comparatively elongate; third one-third longer than first; fourth one-fifth longer than first; rest diminishing in length.

Genotype: Acanthocinus linearis Skinner.

Remarks: This genus belongs in the generic complex consisting of *Eutrichillus*, *Neacanthocinus*, *Ceratographis*, and others, having, in common with them, narrow prosternal and mesosternal processes, the first segment of the metatarsi very elongate, and in general with an elongate, parallel-sided body form. Like *Eutrichillus* and *Ceratographis*, it possesses long flying hairs on the elytra, but, as in the former, it lacks similar hairs on the scape (excluding the usual fringe). From *Eutrichillus*, to which it runs in the key to genera, it differs in having the front broader, as is also the pronotum. The latter, moreover, is bituberculate behind the apical margin, and the fifth sternite in the female is very strongly elongated, being longer than the second to fourth sternites united.

Trichocanonura linearis Skinner

Female: Dark reddish brown, rather densely covered with dull fulvous and ashy pubescence. Head above clouded with fuscous and with a blackish macula behind upper lobe of eye. Pronotum medially with a quadrate, blackish area, at base and at apex somewhat paler; below lateral tubercles with a broad, fuscous vitta extending entire length. Scutellum laterally margined with black. Elytra with a large blackish area covering most of disk except at extreme base, on humeri, and at apex; at apical third an indistinct, oblique, black line, posteriorly from which run two similar lines, convergent before apex; epipleuron black on basal third. Body beneath and legs orange-brown, rather sparsely cinereous pubescent; mesosternal side-pieces broadly tinged with black; abdominal sternites each with a large, fuscous macula at extreme side; tarsi dark brown, segments 1 and 2 basally annulate with ashy. Antennae orange-brown, sparsely ashy pubescent, the segments at base and at apical fifth indistinctly ashy annulate.

Head impunctate, rather deeply impressed between antennal tubercles; front one-half again as broad as tall, with several erect hairs near eye; the latter with the lower lobe oblong, scarcely taller than wide, somewhat narrowed below, slightly taller than gena, upper lobes not quite half so wide as interocular space. Pronotum nearly twice as broad across lateral tubercles as long, sides subparallel, broadly constricted at base; lateral tubercles small but rather prominent, armed with a short, strongly retrorse tooth; disk on each side of middle near apex with a prominent, rounded tubercle, rest of surface nearly simple, densely, coarsely punctate. Elytra with basal gibbosity small, not prominent, bearing a short, tufted crest; disk with four costae posteriorly, scarcely visible on basal half, surface rather sparsely, distinctly punctate, the punctures much finer apically, evanescent before apex; apices obliquely truncate, the angles rounded. Antennae more than one-half again as long as body, the sixth segment nearly attaining elytral apex, beneath with a rather long fringe to apex; scape extending behind middle of pronotum, rather slender; second segment nearly twice as long as wide; third one-third again as long as first; fourth distinctly shorter than third; rest gradually decreasing in length.

Length (excluding ovipositor) 15 mm.; width 5 mm.

Type locality: Carr Canyon, Arizona.

Distribution: Arizona. Arizona: 1, Huachurca Mts. [CAS].

Remarks: The elongate elytra with erect hairs, combined with the large fuscous area on the elytra and on the pronotum, will serve to distinguish this species.

Tylocerina Casey

Astynomus Haldeman, 1847, Trans. Amer. Philos. Soc. (2)10: 46. [non Stephans, 1839].

Graphisurus (*Tylocerina*) Casey, 1913, Mem. Col., IV, p. 335.

Very large, depressed beetles. Head with only a few setigerous punctures on vertex; front very feebly wider than long, slightly narrowed below; eyes with upper lobes separated above by a distance equal to less than twice one of their widths, connected to lower lobes by a broad isthmus (about four rows of facets broad—, lower lobe large, broadly oblong, one-half again as tall as gena. Pronotum subdepressed, a little more than half again as wide as long; lateral tubercles reaching nearer to apical margin than to basal, broad but low, armed at basal two-fifths of pronotum with a short, acute, recurved tooth; disk with punctation fine, sparse, largely concealed medially, with five rather small tubercles; transverse sulci subobsolete. Elytra strongly depressed, with four distinct costae on a apical two-thirds, the innermost continued as a velvety crest on the prominent basal gibbosity; the latter sharply defined posteriorly by a deep, oblique impression; disk sparsely simply punctate only on basal half, with a few granules on the humeri, apically impunctate; apices feebly subtruncate or broadly rounded; sides not deflexed behind middle. Prosternal process one-sixth to one-fifth as broad as a procoxal cavity; mesosternal process about one-third as broad as a mesocoxal cavity, elongate, subparallel-sided, not expanded apically. Fifth sternite in male one-third longer than fourth, in female as long as third and fourth together. Legs successively longer from front to rear; femora robust, strongly and equally capitate on apical half; first segment on protarsi as long as the last, on mesotarsi equal to next two, on metatarsi equal to all the rest. Antennae in male more than three times as long as body, in female about twice as long as body, in both sexes with a very dense, short fringe beneath, at least through the fifth segment; scape slender, not expanded apically, reaching to lateral spines of pronotum; third segment a little more than half again (not quite half again in female) as long as first, arcuate; fourth slightly longer than third in both sexes, nodose at apex in male; in female remaining segments gradually shorter, except eighth and ninth which are subequal to one another, and each slightly longer than seventh, and the eleventh which is equal to fifth; in male fifth to seventh subequal, each nearly one-half again as long as first; eighth longer than fourth, rest gradually more elongated.

Genotype: Cerambyx nodosus Fabricius, by monotypy [*Astynomous* Hald]; herewith designated as the type also for *Tylocerina* Casey.

Remarks: The antennal formula in this genus is quite distinctive, and, in the male, it is the *fourth* segment that is nodulose. The elytral characteristics, in addition, especially the impunctate apical half, the lack of granules (except a very few on humeri), and the distinct costae, are diagnostic.

Since this genus, of all the Nearctic genera, comes closest to the European genus *Acanthocinus*, into which many of our North American species have been mistakenly placed by Aurivillius and others, it might be well to include here a comparison of the two. In *Acanthocinus aedilis* Linné (which is the type of that genus by monotypy), the body is more robust and shorter; the head is densely, rugosely punctate above; the front is scabrose; the eye has the lower lobe distinctly shorter than gena, upper lobes separated above by a distance equal to three times one of their widths, the isthmus between the lobes narrow, composed of two or three rows of facets. The pronotum is transversely rugose on the disk, without tubercles posteriorly, the anterior margin is broadly produced at middle, and the lateral tubercles are armed with a short, *straight*, obtuse tooth. The elytra are granulate-punctate to behind the middle; while the basal gibbosity is without crests and not very prominent. The legs have the femora more slender, not capitate, the mesofemora, being more robust than the metafemora, and the first tarsal segment on all legs is proportionately shorter, that of the metatarsi being not as long as the next three together. In the female the fifth sternite is almost as long as preceding three segments combined. The antennae are densely, briefly fimbriate beneath to apex, with the third segment not more than one-third again as long as first, the fourth without apical node and slightly longer than third. In the female the fifth and seventh segments are subequal to first, the sixth, the ninth, and eleventh are feebly longer than these two, the eighth is equal to the third, and the tenth is shortest of all; but in the male, the fifth to eighth segments gradually increase in length, the ninth and tenth are equal to the eighth, while the eleventh is longest of all. The prosternal process is slightly more than one-fourth as broad as a procoxal cavity and the mesosternal process is nearly one-half as broad as a mesocoxal cavity and not very elongate.

Tylocerina nodosus (Fabricius)

Cerambyx nodosus Fabricius, 1775, Syst. Ent., p. 164; 1781, Spec. Ins., I, p. 209; 1787, Mant. Ins., I, p. 131. Gmelin, *in* Linné, 1788, Syst. Nat., ed. 13. I, 4, p. 1819. Olivier, 1790, Encycl. Meth. Ins., V, p. 291; 1795, Ent., IV, no. 67, p. 75, pl. 14, f. 103.

Lamia nodosus (Fabricius), Fabricius, 1792, Ent. Syst., I, 2, p. 272; 1801, Syst. Eleuth., II, p. 289.
Astynomus nodosus (Fabricius), Haldeman, 1847, Trans. Amer. Philos. Soc. (2)10: 46.
Aedilis nodosus (Fabricius), LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, (2)2: 174.
Acanthocinus nodosus (Fabricius), Horn, 1880, Trans. Amer. Ent. Soc., 8: 130. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 131, 132. Knull, 1946, Bull. Ohio Biol. Surv., 39: 258, pl. 29, f. 1.
Graphisurus (*Tylocerina*) *nodosus* (Fabricius), Casey, 1913, Mem. Col., IV, p. 340.
Lamia bifidator Fabricius, 1801, Syst. Eleuth., II, p. 286 [♀].
Graphisurus (*Tylocerina*) *laticollis* Casey, 1913, Mem. Col., IV, p. 340 [new syn.].

Male: Dark ferrugineous to piceous, elytra sometimes in part testaceous; entirely densely clothed with lead gray or brownish gray pubescence; on each side from behind eye a broad black or fuscous vitta extending across pronotum onto the basal two-fifths of sides of elytra and narrowly along sides of meso- and metasternal side-pieces and continued along abdomen laterally to base of fifth sternite. Head with front and occiput tinged with blackish. Pronotum at apex with an oblique, black streak each side of middle, opposed at base by similar longitudinal ones and with a small, black, median macula. Elytra each with a black vitta at base near scutellum, attaining basal fourth and before apex a slender, triangular, black plaga, enclosing a pale macula at its apical end and bifurcated at its anterior end, these bifurcations continued basad by a series of black and whitish streaks and dots; the subhumeral black vitta is trifurcated posteriorly, the two inner forks continued caudad by a series of black dots and short streaks. Femora nearly immaculate, except for a few denuded punctures; tibiae and tarsi black, the former with a narrow annulus at extreme base and another one broad, oblique, before middle, of gray. Antennae with scape narrowly black at apex and more broadly so along the external side; second segment black, rest black on apical halves.

Entire upper surface minutely, densely punctulate and feebly alutaceous. Head with a few setigerous punctures around upper lobe of eye; eye with lower lobes oblong, vertical, one-half again as tall as gena, upper lobes separated above by less than twice their width. Pronotum slightly more than half again as wide as long; lateral tubercles robust, not prominent, terminating slightly behind middle in a short, acute tooth which is curved posteriorly; disk sparsely, finely punctate, the punctures medially in part concealed by the pubescence, with five small tubercles, the three posterior ones less prominent than the two anterior. Elytra with basal gibbosity prominent, bearing a linear, velvety covered crest, sharply defined posteriorly by a broad, deep impression; disk behind this impression with three or four costae, three of which anastomose before apex, finely sparsely punctate to slightly behind middle, thence impunctate to apex; humeri more coarsely and densely punctate, nearly without granules. Fifth sternite about one-third longer than fourth, broadly angularly emarginate at apex.

Female: As male but fifth sternite as long as the two preceding segments; antennae lacking the nodule at apex of fourth segment.

Length 18–26 mm.; width 6–8.5 mm.

Type localities: Maryland [*nodosus*]; North America [*bifidator*]; Southern Pines, North Carolina [*laticollis*].

Distribution: Pennsylvania and Florida west to Arkansas and Texas. Pennsylvania: 1, Mt. Alto, July 1 (J. N. Knull) [TAM]. Maryland: 1, no further data [Minn.]. North Carolina: 1, no further data [CU]. Georgia: 2, Charlton Co., May 7–8, 1933 [Miami]. Florida: 1, no further data [Minn.]; 1, Sarasota, Nov. 3, 1950 (W. Hegener) [CU]; 2, Miami, Jan. and March [Miami]. Mississippi: 1, Lucedale, Feb. 28, 1930 (H. Dietrich) [CU]. Arkansas: 1, Hope, June 19, 1925 (L. Knobel) [CU]. Texas: 2, College Station, April 20, 1917 and May 19, 1948 (H. J. Reinhard) [TAM].

Remarks: In addition to its unique maculation, this species is quite distinct in lacking punctures on the apical half of the elytra.

Neacanthocinus Dillon, gen. nov.

Rather slender, moderate-sized beetles, having the front of head one-sixth to one-fifth broader than high, narrowed below and between eyes; eye with lower lobe tapering below or suboblong, erect, one-sixth again as tall as gena, upper lobes separated by twice (or three times in *pusillus*) their width, isthmus ranging from three to five rows of facets broad. Pronotum subcylindrical, two-thirds again as wide as long, sides irregular, wider before middle than at base, then strongly, narrowly constricted at apex; lateral tubercles placed at basal two-fifths, small, slightly prominent, armed with a short, acute tooth that is directed slightly caudad; disk moderately finely punctate, the punctures irregularly and not densely placed over entire surface, surface elevated anteriorily, then suddenly depressed and constricted to apex, with two low tubercles just behind apical constriction, one each side of middle; transverse sulci poorly defined, the basal one somewhat more distinct. Elytra cylindrical, each with two interrupted, feebly elevated costae on disk, the outer one (extending from near humerus) more distinct, and with a lateral one on apical half, none of the costae bearing tufts (except in *obliquus*); basal gibbosity rather prominent, smallish, without crest; disk either finely or rather coarsely punctate, the punctures deep, distinct, simple, usually rather densely, fairly uniformly placed, at least on basal half; apices rounded separately or angularly truncate. Prosternal process one-sixth as wide as a procoxal

Length (excluding ovipositor) 15 mm.; width 5 mm.

Type locality: Carr Canyon, Arizona.

Distribution: Arizona. Arizona: 1, Huachurca Mts. [CAS].

Remarks: The elongate elytra with erect hairs, combined with the large fuscous area on the elytra and on the pronotum, will serve to distinguish this species.

Tylocerina Casey

Astynomus Haldeman, 1847, Trans. Amer. Philos. Soc. (2)10: 46. [non Stephans, 1839].
Graphisurus (*Tylocerina*) Casey, 1913, Mem. Col., IV, p. 335.

Very large, depressed beetles. Head with only a few setigerous punctures on vertex; front very feebly wider than long, slightly narrowed below; eyes with upper lobes separated above by a distance equal to less than twice one of their widths, connected to lower lobes by a broad isthmus (about four rows of facets broad—, lower lobe large, broadly oblong, one-half again as tall as gena. Pronotum subdepressed, a little more than half again as wide as long; lateral tubercles reaching nearer to apical margin than to basal, broad but low, armed at basal two-fifths of pronotum with a short, acute, recurved tooth; disk with punctation fine, sparse, largely concealed medially, with five rather small tubercles; transverse sulci subobsolete. Elytra strongly depressed, with four distinct costae on a apical two-thirds, the innermost continued as a velvety crest on the prominent basal gibbosity; the latter sharply defined posteriorly by a deep, oblique impression; disk sparsely simply punctate only on basal half, with a few granules on the humeri, apically impunctate; apices feebly subtruncate or broadly rounded; sides not deflexed behind middle. Prosternal process one-sixth to one-fifth as broad as a procoxal cavity; mesosternal process about one-third as broad as a mesocoxal cavity, elongate, subparallel-sided, not expanded apically. Fifth sternite in male one-third longer than fourth, in female as long as third and fourth together. Legs successively longer from front to rear; femora robust, strongly and equally capitate on apical half; first segment on protarsi as long as the last, on mesotarsi equal to next two, on metatarsi equal to all the rest. Antennae in male more than three times as long as body, in female about twice as long as body, in both sexes with a very dense, short fringe beneath, at least through the fifth segment; scape slender, not expanded apically, reaching to lateral spines of pronotum; third segment a little more than half again (not quite half again in female) as long as first, arcuate; fourth slightly longer than third in both sexes, nodose at apex in male; in female remaining segments gradually shorter, except eighth and ninth which are subequal to one another, and each slightly longer than seventh, and the eleventh which is equal to fifth; in male fifth to seventh subequal, each nearly one-half again as long as first; eighth longer than fourth, rest gradually more elongated.

Genotype: Cerambyx nodosus Fabricius, by monotypy [*Astynomous* Hald]; herewith designated as the type also for *Tylocerina* Casey.

Remarks: The antennal formula in this genus is quite distinctive, and, in the male, it is the *fourth* segment that is nodulose. The elytral characteristics, in addition, especially the impunctate apical half, the lack of granules (except a very few on humeri), and the distinct costae, are diagnostic.

Since this genus, of all the Nearctic genera, comes closest to the European genus *Acanthocinus*, into which many of our North American species have been mistakenly placed by Aurivillius and others, it might be well to include here a comparison of the two. In *Acanthocinus aedilis* Linné (which is the type of that genus by monotypy), the body is more robust and shorter; the head is densely, rugosely punctate above; the front is scabrose; the eye has the lower lobe distinctly shorter than gena, upper lobes separated above by a distance equal to three times one of their widths, the isthmus between the lobes narrow, composed of two or three rows of facets. The pronotum is transversely rugose on the disk, without tubercles posteriorly, the anterior margin is broadly produced at middle, and the lateral tubercles are armed with a short, *straight*, obtuse tooth. The elytra are granulate-punctate to behind the middle; while the basal gibbosity is without crests and not very prominent. The legs have the femora more slender, not capitate, the mesofemora, being more robust than the metafemora, and the first tarsal segment on all legs is proportionately shorter, that of the metatarsi being not as long as the next three together. In the female the fifth sternite is almost as long as preceding three segments combined. The antennae are densely, briefly fimbriate beneath to apex, with the third segment not more than one-third again as long as first, the fourth without apical node and slightly longer than third. In the female the fifth and seventh segments are subequal to first, the sixth, the ninth, and eleventh are feebly longer than these two, the eighth is equal to the third, and the tenth is shortest of all; but in the male, the fifth to eighth segments gradually increase in length, the ninth and tenth are equal to the eighth, while the eleventh is longest of all. The prosternal process is slightly more than one-fourth as broad as a procoxal cavity and the mesosternal process is nearly one-half as broad as a mesocoxal cavity and not very elongate.

Tylocerina nodosus (Fabricius)

Cerambyx nodosus Fabricius, 1775, Syst. Ent., p. 164; 1781, Spec. Ins., I, p. 209; 1787, Mant. Ins., I, p. 131. Gmelin, *in* Linné, 1788, Syst. Nat., ed. 13. I, 4, p. 1819. Olivier, 1790, Encycl. Meth. Ins., V, p. 291; 1795, Ent., IV, no. 67, p. 75, pl. 14, f. 103.

Lamia nodosus (Fabricius), Fabricius, 1792, Ent. Syst., I, 2, p. 272; 1801, Syst. Eleuth., II, p. 289.
Astynomus nodosus (Fabricius), Haldeman, 1847, Trans. Amer. Philos. Soc. (2)10: 46.
Aedilis nodosus (Fabricius), LeConte, 1852, Jour. Acad. Nat. Sci. Philadelphia, (2)2: 174.
Acanthocinus nodosus (Fabricius), Horn, 1880, Trans. Amer. Ent. Soc., 8: 130. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 131, 132. Knull, 1946, Bull. Ohio Biol. Surv., 39: 258, pl. 29, f. 1.
Graphisurus (*Tylocerina*) *nodosus* (Fabricius), Casey, 1913, Mem. Col., IV, p. 340.
Lamia bifidator Fabricius, 1801, Syst. Eleuth., II, p. 286 [♀].
Graphisurus (*Tylocerina*) *laticollis* Casey, 1913, Mem. Col., IV, p. 340 [new syn.].

Male: Dark ferrugineous to piceous, elytra sometimes in part testaceous; entirely densely clothed with lead gray or brownish gray pubescence; on each side from behind eye a broad black or fuscous vitta extending across pronotum onto the basal two-fifths of sides of elytra and narrowly along sides of meso- and metasternal side-pieces and continued along abdomen laterally to base of fifth sternite. Head with front and occiput tinged with blackish. Pronotum at apex with an oblique, black streak each side of middle, opposed at base by similar longitudinal ones and with a small, black, median macula. Elytra each with a black vitta at base near scutellum, attaining basal fourth and before apex a slender, triangular, black plaga, enclosing a pale macula at its apical end and bifurcated at its anterior end, these bifurcations continued basad by a series of black and whitish streaks and dots; the subhumeral black vitta is trifurcated posteriorly, the two inner forks continued caudad by a series of black dots and short streaks. Femora nearly immaculate, except for a few denuded punctures; tibiae and tarsi black, the former with a narrow annulus at extreme base and another one broad, oblique, before middle, of gray. Antennae with scape narrowly black at apex and more broadly so along the external side; second segment black, rest black on apical halves.

Entire upper surface minutely, densely punctulate and feebly alutaceous. Head with a few setigerous punctures around upper lobe of eye; eye with lower lobes oblong, vertical, one-half again as tall as gena, upper lobes separated above by less than twice their width. Pronotum slightly more than half again as wide as long; lateral tubercles robust, not prominent, terminating slightly behind middle in a short, acute tooth which is curved posteriorly; disk sparsely, finely punctate, the punctures medially in part concealed by the pubescence, with five small tubercles, the three posterior ones less prominent than the two anterior. Elytra with basal gibbosity prominent, bearing a linear, velvety covered crest, sharply defined posteriorly by a broad, deep impression; disk behind this impression with three or four costae, three of which anastomose before apex, finely sparsely punctate to slightly behind middle, thence impunctate to apex; humeri more coarsely and densely punctate, nearly without granules. Fifth sternite about one-third longer than fourth, broadly angularly emarginate at apex.

Female: As male but fifth sternite as long as the two preceding segments; antennae lacking the nodule at apex of fourth segment.

Length 18–26 mm.; width 6–8.5 mm.

Type localities: Maryland [*nodosus*]; North America [*bifidator*]; Southern Pines, North Carolina [*laticollis*].

Distribution: Pennsylvania and Florida west to Arkansas and Texas. Pennsylvania: 1, Mt. Alto, July 1 (J. N. Knull) [TAM]. Maryland: 1, no further data [Minn.]. North Carolina: 1, no further data [CU]. Georgia: 2, Charlton Co., May 7–8, 1933 [Miami]. Florida: 1, no further data [Minn.]; 1, Sarasota, Nov. 3, 1950 (W. Hegener) [CU]; 2, Miami, Jan. and March [Miami]. Mississippi: 1, Lucedale, Feb. 28, 1930 (H. Dietrich) [CU]. Arkansas: 1, Hope, June 19, 1925 (L. Knobel) [CU]. Texas: 2, College Station, April 20, 1917 and May 19, 1948 (H. J. Reinhard) [TAM].

Remarks: In addition to its unique maculation, this species is quite distinct in lacking punctures on the apical half of the elytra.

Neacanthocinus Dillon, gen. nov.

Rather slender, moderate-sized beetles, having the front of head one-sixth to one-fifth broader than high, narrowed below and between eyes; eye with lower lobe tapering below or suboblong, erect, one-sixth again as tall as gena, upper lobes separated by twice (or three times in *pusillus*) their width, isthmus ranging from three to five rows of facets broad. Pronotum subcylindrical, two-thirds again as wide as long, sides irregular, wider before middle than at base, then strongly, narrowly constricted at apex; lateral tubercles placed at basal two-fifths, small, slightly prominent, armed with a short, acute tooth that is directed slightly caudad; disk moderately finely punctate, the punctures irregularly and not densely placed over entire surface, surface elevated anteriorily, then suddenly depressed and constricted to apex, with two low tubercles just behind apical constriction, one each side of middle; transverse sulci poorly defined, the basal one somewhat more distinct. Elytra cylindrical, each with two interrupted, feebly elevated costae on disk, the outer one (extending from near humerus) more distinct, and with a lateral one on apical half, none of the costae bearing tufts (except in *obliquus*); basal gibbosity rather prominent, smallish, without crest; disk either finely or rather coarsely punctate, the punctures deep, distinct, simple, usually rather densely, fairly uniformly placed, at least on basal half; apices rounded separately or angularly truncate. Prosternal process one-sixth as wide as a procoxal

cavity, mesosternal process one-third as broad as a mesocoxal cavity. Fifth sternite in male scarcely longer than fourth, deeply emarginate at apex, in female longer than third and fourth, in *obsoletus* nearly as long as second to fourth together. Antennae one and one-half (♀) or two to two and a half (♂) times as long as the body, beneath densely and briefly fimbriate nearly to apex; scape elongate, reaching at least to basal fourth of pronotum, not expanded beneath at apex; third segment one-fifth (♂) or two-fifths (♀) again as long as first; fourth subequal to or slightly longer than third in male, slightly shorter in female; in male fifth to seventh subequal to third or gradually shorter than it, eighth to eleventh subequal or gradually longer; in female fourth and following gradually shorter than third. Legs successively longer from front to rear, the hind pair much longer; femora comparatively slender, equally capitate on apical halves; protarsi with first segment slightly shorter than next two together, mesotarsal first segment one-tenth shorter and metatarsal first segment one-third longer, than remaining segments combined.

Genotype: Cerambyx obsoletus Olivier.

Remarks: There is a strong superficial resemblance in maculation between this genus and *Graphisurus*, but the latter is at once distinguished from the present one by its short antennae and by the presence of long, erect setae on the body above, especially on the elytra. In the present genus, the outstanding characters are found in the antennae, which are densely fimbriate beneath nearly to apex and which are not more than two and a half times as long as the body in the male and only one and a half times as long in the female. The scape is quite elongate, reaching to basal fourth of pronotum, and none of the segments bears nodules. The elytral punctation is simple and attains apex, and the costae are fairly prominent but interrupted.

N. obliquus (LeConte) is placed here after considerable hesitation, for in many ways it is quite different from the other members of the genus, and it may have to be removed to a genus of its own. In the first place the antennae are considerably longer in both sexes (attaining twice the body length in the female, three times in the male) and are densely fimbriate only to the fifth segment, the scape is not quite so elongate; and the antennal formula is slightly different. The pronotum is tumid on each side and trinodulose there; the tarsal first segment is not quite so elongate; and the elytral costae are tufted.

KEY TO SPECIES

1. Tarsi entirely fuscous, not annulate..... **obsoletus**
   Tarsi fuscous, the first two segments distinctly hoary annulate..... 2
2. Elytral costae prominent, with distinct maculae of fuscous pubescence forming short tufts.... **obliquus**
   Elytral costae feeble, without maculae of longer pubescence..... **pusillus**

Neacanthocinus obsoletus (Olivier)

(Fig. 4)

Cerambyx obsoletus Olivier, 1795, Ent. IV, no. 67, p. 130, pl. 13, f. 90.

Aedilis obsoletus (Olivier), LeConte, 1852, Proc. Acad. Nat. Sci. Philadelphia, (2)2: 174.

Acanthocinus obsoletus (Olivier), Horn, 1880, Trans. Amer. Ent. Soc., 8: 130. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc. 23: 132. Wickham, 1898, Can. Ent. 30: 38. Schaeffer, 1902, Ent. News, 13: 236. Blatchley, 1910, Col. Ind., p. 1079. Knull, 1946, Bull. Ohio Biol. Surv., 39: 258.

Graphisurus obsoletus (Olivier), Casey, 1913, Mem. Col., IV, p. 335.

Graphisurus floridanus Casey, 1913, Mem. Col. IV, p. 336. [New syn.].

Male: Dark ferrugineous or dull testaceous, rather densely covered with cinereous pubescence, and maculate with fuscous as follows: Head sometimes with vague maculae along occiput. Pronotum with two preapical maculae side by side near middle, each often extending obliquely laterad to coalesce with a less distinct macula above lateral tubercle; disk at middle occasionally fuscous clouded. Scutellum rather broadly margined on each side. Elytra each with a scutellar macula and four oblique, parallel fasciae, the first sutural, at basal fourth, the second from side at basal fourth to before middle near suture, the third post median, usually entire, and the last much interrupted, from apical fourth to near apex at suture, all these fasciae interrupted to a greater or lesser extent and varying greatly in their widths, the interspaces sprinkled with small flecks. Body beneath and femora rather densely fuscous punctate, the latter usually with a more or less distinct preapical annulus; tibiae with a subbasal annulus and a much broader one at apex; tarsi entirely fuscous. Antennae fuscous, with all segments broadly annulate basally with ashy.

Entire upper surface minutely alutaceous and finely, densely punctulate. Head with three or four setigerous punctures above near eyes and with several on margins of front; front one-sixth wider than high, narrowed above and below; eye with lower lobe oblong, erect, one-sixth again as tall as gena, upper lobes separated above by about twice their width, the isthmus four or five rows of facets wide. Pronotum two-thirds again as wide as long; the lateral tubercles rather small, low, armed at apex with a short, backward-directed, obtuse spine, placed at basal third: disk elevated anteriorly, then suddenly depressed and constricted, with two low tubercles before apical constriction, one each side of middle, rather coarsely, irregularly, and somewhat sparsely punctate, more densely so along apical and basal margins. Elytra with basal gibbosity prominent, rather small, without crest; disk with several, usually obsolete costae, rather coarsely and densely punctate at the base, the punctures gradually sparser apically, extending close to apex, on humeri a few bearing granules; apices

strongly obliquely truncate at suture, the external angle pronounced. Prosternal process one-sixth as wide as a procoxal cavity; mesosternal process one-third as broad as a mesocoxal cavity. Fifth sternite feebly longer than fourth, rather deeply emarginate at apex. Antennae two and one-half times as long as body, beneath densely and briefly fimbriate nearly to apex; scape elongate, extending behind pronotal lateral tubercle; third segment one-fifth or more longer than first; fourth very feebly longer than third, fifth to seventh subequal, as long as third, rest successively gradually more elongate.

Female: Similar to male, but fifth sternite not quite so long as preceding three segments together, its apex very deeply acutely emarginate; antennae one and one-half times as long as body, but third segment distinctly longer than first and feebly longer than fourth; fifth much shorter than fourth, rest gradually diminishing in length.

Length 7–14 mm., width 2.5–4 mm.

Type localities: Carolina and Pennsylvania (*obsoletus*); Florida (*floridanus*).

Distribution: Eastern North America, west to Minnesota and Texas. Ontario: 6, Toronto, May–Aug. [CU]. Massachusetts: 1, Plymouth Co. [CU]. New York: 1, Ithaca, June [CU]. Pennsylvania: 2, Alleghany Co., June 21, 1892 (E. A. Klages) [CU]. Maryland: 8, no further data [Minn.] Illinois: 1, no further data [Minn.]. Michigan: 1, no further data [Minn.] Minnesota: 1, Itasca, June [Minn.] Alabama: 1, Auburn, Oct. 1, 1911 (H. G. Good) [TAM]. Florida: 1, Sanford, March [CU]; 1, Dunedin [CU]; 1, Palatka, May [CU]. Arkansas: 7, Hope, June–Oct. [CU]. Mississippi: 1, Agricultural College, March [CU]; 1, N. Augusta, March (Dietrich) [CU]; 9, Lucedale, Nov. to April [CU]. Texas: 1, College Station, Sept. 2, 1942 (H. J. Reinhard) [TAM]; 2, Morris Co., July 3, 1937 [TAM]; 1, Daingerfield [TAM].

Neacanthocinus pusillus (Kirby)

Acanthocinus (*Graphisurus*) *pusillus* Kirby, 1837, Fauna Bor.-Amer., IV, p. 169. Horn, 1880, Trans. Amer. Ent. Soc., 8: 129 [ex parte]. Schaeffer, 1902, Ent. News, 13: 236. Knull, 1946, Bull. Ohio Biol. Surv., 39: 258.
Graphisurus pusillus Kirby, Casey, 1913, Mem. Col. IV, p. 336.

Male: Dark ferrugineous to piceous, rather densely covered with fine cinereous pubescence. Head on vertex and upper part of front tinged with fulvous, indistinctly marked with fuscous on each antennal tubercle and more broadly so on upper half of front; sometimes broadly fuscous on vertex from between eyes to occiput. Pronotum with a broad, subquadrate, median, fuscous patch, sometimes varied with fulvous, and with an arcuate, transverse series of four rounded, fulvous maculae apically. Scutellum cinereous pubescent, at middle of base and along each side maculate with fuscous. Elytra with four fuscous, oblique bands, the first at extreme base, much interrupted or macular, poorly defined, the second extending from close to side margin behind humerus to suture at basal third, usually interrupted on disk and reflexed near suture, third somewhat undulating but not interrupted, extending from behind middle of deflexed portion of sides to apical third at suture, and fourth preapical, irregular, often maculiform; entire disk irregularly sprinkled with fuscous points, which are (as are portions of the bands) somewhat margined with fulvous. Body beneath and legs dull testaceous to piceous, rather thinly clothed with cinereous pubescence and indistinctly tinged here and there with pale fulvous; femora fuscous maculate above before apex, on metafemora the macula nearly forming an annulus; tibiae narrowly annulate with fuscous near base and broadly so at apex; tarsi fuscous, broadly annulate with ashy on bases of first two segments. Antennae fuscous, scape broadly, third and following segments narrowly, annulate with ashy at base.

Entire upper surface minutely alutaceous and finely, rather densely punctulate. Head with two or three setigerous punctures near upper lobes of eyes and three or four more along frontal margin of lower lobes; front one-fifth wider than high; eye with lower lobe narrow, upright, somewhat tapering below, one-sixth taller than gena, upper lobes narrow, separated by nearly three times their width, the isthmus only three rows of facets wide. Pronotum two-thirds again as wide as long; lateral tubercles rather low, rounded, armed at apex with a short, obtuse tooth directed upwards and slightly caudad, placed at basal third; disk finely, not densely, irregularly punctate, anteriorly elevated, then suddenly depressed and constricted to apex, before constriction with two close-set tubercles. Elytra with basal gibbosity prominent, rather small, without a crest; disk with several more or less obsolete costae, finely and rather densely punctate, the punctures very sparse apically; apices separately rounded. Prosternal process one-sixth as wide as a procoxal cavity; mesosternal process one-third as broad as a mesocoxal cavity. Fifth sternite scarcely longer than fourth, broadly, deeply emarginate at apex. Antennae not more than twice as long as body, beneath densely and briefly fimbriate; scape elongate, extending behind lateral tubercle of pronotum; third segment one-fifth again as long as first; fourth subequal to third; fifth to sixth gradually shorter; seventh and following each subequal to sixth.

Female: As in male, but fifth sternite slightly longer than third and fourth segments together, its apex very deeply, acutely emarginate; antennae about one and one-half times as long as body, third segment two-fifths again as long as first and slightly longer than fourth, rest gradually shorter.

Length 7–10 mm. (exclusive of ovipositor); width 2.6 mm.

Type locality: Between New York and Cumberland House.

Distribution: The northern tier of States from Maine to Minnesota and into Alaska. Maine: 2, Paris, June 24, 1922 [CU]. New York: 1, Black Brook, Clinton Co., June 21, 1915 [CU]; 2, Ithaca, July [CU]. Minnesota: 4, no further data [CU]; 22, Itasca Park, May-July [Minn.]; 2, Cass Co., June 22 (O. W. Oestlund) [Minn.]; 2, Olmstead Co. (C. N. Ainslee) [Minn.]; 1, Kittson Co. (O. W. Oestlund) [Minn.]. Alaska: 1, Fairbanks, July 9, 1947 [USNM].

Remarks: Superficially this species resembles *obsoletus* very closely; however, the rounded elytral apices of the present form will at once distinguish it. Furthermore, it is distinct in having shorter antennae, narrower and more widely separated upper ocular lobes, finer punctation on the pronotum and elytra, and different coloration on the pronotum, not to mention a narrower ashy annulation of the antennal segments in both sexes and a shorter fifth sternite in the female.

Neacanthocinus obliquus obliquus (LeConte)

(Fig. 2)

Aedilis obliquus LeConte, 1862, Proc. Acad. Nat. Sci. Philadelphia, 14: 39.

Acanthocinus obliquus (LeConte), Horn, 1880, Trans. Amer. Ent. Soc., 8: 130. Leng and Hamilton, 1896, Trans. Amer. Ent. Soc., 23: 132.

Graphisurus obliquus (LeConte), Casey, 1913, Mem. Col., IV, p. 337.

Graphisurus obliquus sedulus Casey, 1913, Mem. Col., IV, p. 337. [new syn.].

Graphisurus angulosus Casey, 1913, Mem. Col., IV, p. 338 [new syn.].

Graphisurus acomanus Casey, 1913, Mem. Col., IV, p. 337 [new syn.]

Male: Dark ferrugineous to piceous, not very densely covered with short, cinereous pubescence and maculate and mottled with often longer, fuscous pubescence. Head above and on front strongly and broadly clouded with fuscous, often reducing the cinereous areas to margins of eyes and lower portion of front. Pronotum typically broadly fuscous at center, enclosing a fine, usually broken, median line and a rounded macula each side of middle at apical fourth, from each macula an oblique, arcuate streak extending towards base, all cinereous; these cinereous markings may be much modified in form and extent. Scutellum cinereous, broadly margined with fuscous each side. Elytra with basal and apical fourths maculate with fuscous to a greater or lesser extent, and with two oblique, irregularly dentate bands of fuscous, one at basal third, the second at apical two-fifths, both variable in width and shape; costae usually fuscous, interrupted by cinereous maculae. Body beneath on sides and femora densely mottled with glabrous dots; femora with an incomplete, fuscous annulus before apex; tibiae broadly fuscous annulate at apex and more narrowly so at basal third; tarsi fuscous, first two segments ashy annulate at base. Antennal segments, except last two or three, with apices broadly infuscated and covered with fuscous or brown pubescence, rest cinereous pubescent, segments 3 to 8 usually with at least a trace of darker pubescence near base, causing a biannulated appearance.

Entire upper surface minutely alutaceous. Head in addition densely, rugosely punctulate and with a few fine punctures on vertex and front; the latter one-fifth broader than high, rather strongly narrowed below eye to mouth; eye with lower lobe subtriangular, slightly taller than gena. Pronotum two-thirds again as broad as long, sides irregular, broader before middle than at base, narrowly constricted at apex; lateral tubercles small, prominent, armed with a long, acute, recurved tooth; disk each side subtriangularly tumid and with three feebly elevated callosities, at middle with a fine, elongate tubercle on basal half, entire surface sparsely, rather coarsely punctate. Elytra rather coarsely, densely punctate except on the strongly elevated costae, punctures suddenly becoming sparse behind middle to apex; apices broadly, separately rounded. Prosternal process one-sixth as broad as a procoxal cavity; mesosternal process two-fifths as broad as a mesocoxal cavity; fifth sternite one-fourth again as long as the fourth, broadly, rather deeply emarginate to apex. Antennae two to three times as long as body, rather slender, fairly densely, briefly fimbriate beneath on first four segments; scape reaching to basal third of pronotum, slightly expanded downwards at apex; third segment one-fourth longer than first; fourth and fifth successively longer than third, sixth subequal to fifth, seventh and following gradually longer.

Female: A little more robust than male. Fifth sternite as long as third and fourth together, very deeply emarginate at apex. Antennae nearly twice as long as body, less densely fimbriate beneath on first four segments, third segment one-seventh longer than first, fourth subequal to third; fifth distinctly shorter than fourth, rest very feebly diminishing in length.

Length 9.5–14 mm.; width 3–4 mm.

Type localities: Kansas, New Mexico, Arizona, and California [*obliquus*]; Fort Wingate, New Mexico [*sedulus*]; New Mexico [*angulosus*;*acomanus*].

Distribution: Rocky Mountain States and into South Dakota. New Mexico: 1, no further data [Minn.]; 1, Hot Springs, Las Vegas, Aug., 1882 (F. H. Snow) [CU]; 1, Las Vegas [USNM]; 1, Rowe, June 1 [Col.]. Arizona: 1, White Mts. Apache Co., June [CU]. Colorado: 1, no further data [WSC]; 1, Larkspur, May [USNM]; 1, Boulder Co., July 12 [Col.]. Idaho: 1, Moscow [WSC]; 1, Collins, July 27, 1898 [WSC]; 1, Centerville [USNM]. South Dakota: 13, Elmore

[USNM]; 3, Black Hills [USNM]; 2, Custer [USNM].

Remarks: The length of the antennae is quite variable in the species, especially in the male. Hence Casey's species, which were based solely on this character or on the equally variable coloration of the elytra, are not distinguishable.

Breeds in pines, including *P. scopulorum.*

Neacanthocinus obliquus pacificus Casey

(Fig. 3)

Graphisurus pacificus Casey, 1913, Mem. Col., IV, p. 338.

As in the nymotype except that the body pubescence is much whiter. Pronotum with median blackish area usually enclosing two oblique, white streaks before middle. Elytra with blackish markings more extensive, especially the band at basal third, from which emanate long processes frequently coalescing with the postmedian band, leaving fine, white vittae between them. Antennae as a rule without darker pubescence in the hoary annulations, at least to the extent that a biannulate appearance fails to arise.

Length: 9–12.5 mm.; width 3.2–3.8 mm.

Type locality: Siskiyou Co., California.

Distribution: Pacific States. Washington: 1, Pullman [WSC]. Oregon: 4, Prineville, July [USNM]; 1, Crater Lake [USNM]. California: 2; Madera Co., Chiquito Creek, July (H. Dietrich) [CU]. 3, Modoc Co., July 8, 1939 [CU]; 2, Hetch Hetchy [CU]; 1, Pinnacle National Mon. [USNM]; 1, Yosemite Pk. [USNM]; 1, Calaveros Big Tree, June [USNM]; 1, Pope Valley, Napa Co., Apr. [USNM].

Breeds in *Pinus*, including *P. ponderosa* and *P. murrayana.*

EXPERIMENTAL EVIDENCE FOR SIBLING SPECIES IN THE OLEANDER SCALE, ASPIDIOTUS HEDERAE (VALLOT)[1]

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Various diaspine scales were tested as hosts during the process of developing an efficient mass culture method for rearing the parasite, *Aphytis* "A". The first laboratory host tested, *Aonidiella aurantii* (Mask.), was the scale against which the parasites were to be tested in the field, but it did not prove to be a highly satisfactory laboratory host. Beginning in 1952 various other diaspine scales were examined as possible laboratory hosts including the oleander scale, *Aspidiotus hederae* (Vallot).

Stocks of this scale were obtained from the field in southern California from various localities and host plants. These collections were found to represent two apparently different forms of oleander scale inasmuch as in certain cultures males appeared, and in others the females reproduced uniparentally. Preliminary tests with oleander scale in 1952 had indicated that it might serve as a highly satisfactory laboratory host for the mass culture of *Aphytis* "A", consequently it immediately became desirable to determine whether or not two distinct forms actually existed and, if so, which was the more efficient host for parasite mass culture.

A search of the literature showed that Bodenheimer (1951) reported only biparental oleander scale in Palestine. Gabritchevsky (1925) reported both biparental and uniparental female cultures in Russia, the biparental cultures living on *Aucuba japonica* and the uniparental culture growing best on a variety of palms. Schrader (1929) stated that the "race" from oleander is always uniparental and when transferred to palm, ivy, or *Aucuba* no males appeared. In a limited survey in southern California we have found both the uniparental and biparental forms occurring as distinct populations on oleander and on variegated and green English ivy. Therefore, with these two common plant hosts there seems to be little possibility of the host plant influencing the production of males. One form or the other has been found on various other host plants.

When mature specimens of both forms were submitted to two taxonomists, Howard L. McKenzie of the California State Department of Agriculture and R. C. Dickson of the University of California Citrus Experiment Station, both forms were determined as *Aspidiotus hederae.* Ferris (1938), however, in his discussion of this species admits the possibility that more than one species may be included under *Aspidiotus hederae.* The results which follow in this paper strengthen this possibility.

TECHNIQUES

Scale culture selection. The first collections of oleander scale used in this experiment were intended for mass culture studies and were obtained from four localities in southern California.

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The scale was taken on oleander, *Nerium oleander* at San Juan Capistrano and Santa Ana, Orange County. At Goleta, Santa Barbara County, the scale was taken on lemon fruit in a commercial orchard. At Riverside, Riverside County, the scale was taken on English ivy, *Nepeta hederacea*. Only the latter culture yielded males and females; all the others consisted entirely of female scales.

Cultures from all four localities were started on citron melons and White Rose potato tubers for preliminary tests and observations. Inasmuch as no highly significant differences were found between the three uniparental cultures, one (the Santa Ana oleander collection) was chosen for use in comparative tests with the biparental culture obtained from English ivy at Riverside. This paper then will be restricted to a description of some of the biological differences which exist between the biparental form taken at Riverside and the uniparental form taken near Santa Ana.

Testing method. In order to determine which form of oleander scale might be preferable for use as a host in the mass production of *Aphytis* "A", it was necessary to gain a clearer understanding of the different biological characteristics possessed by each of these two forms. The various comparative tests which follow were designed toward this end.

Plant hosts. When host plants were involved, the same plants were always used for each form so that a differential host plant response might be eliminated as a possible factor. With few exceptions the host plants used in these tests were mature green lemons all picked from the same tree in a grove near Claremont, California. Soon after being picked, the lemons were brought back to the Riverside laboratory where they were dipped into paraffin wax until each fruit was approximately three-quarters submerged. Waxing in this manner reduced the amount of water loss from the fruit so that they remained in a healthy turgid condition for long periods.

Temperature and humidity control. Constant temperature cabinets wherein the temperature fluctuation was not in excess of ½° F. housed the test units. The desired humidities at the different temperatures were achieved through the use of various dilutions of H_2SO_4 in the test units.

In an attempt to determine optimum developmental conditions for the two forms, all of the tests were run at relative humidities of 40, 50, 60, 70, and 80% and at temperatures of 65, 70, 75, and 80° F.

Test Unit. The test unit consisted of two vertically placed jars (fig. 1) fastened together by means of two screw type mason jar lids soldered back to back and with each containing a rubber gasket. The lower jar was a wide mouth pint mason jar containing the diluted H_2SO_4. The upper jar consisted of the upper half of a wide mouth quart mason jar (previously cut in two by means of a hot wire) with its cut surface ground smooth. A square piece of ¼" plate glass was sealed onto the ground edge by means of white vaseline. A wire basket inside the upper jar supported fruit or vials. A fine mesh cloth membrane beneath this basket prevented detritus from falling into the acid which would cause fuming and consequent harm to the insects being tested.

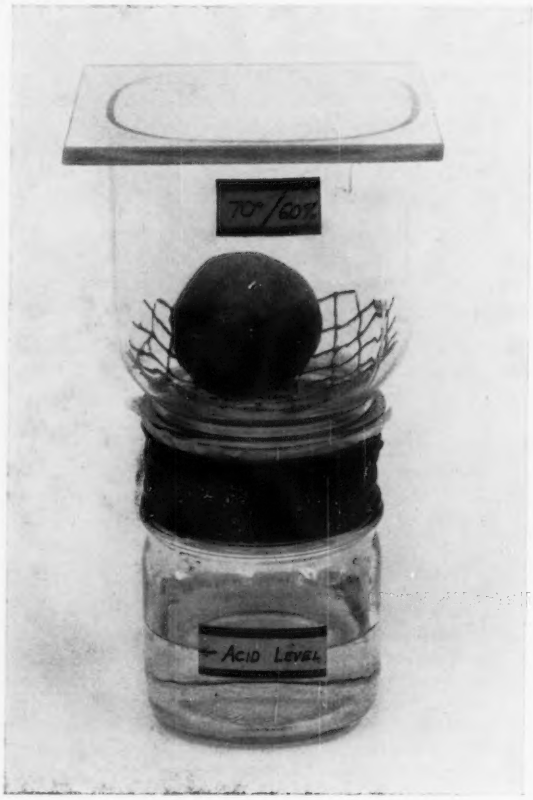

FIG. 1. Test unit affording precise humidity control at any given temperature.

RESULTS OF COMPARISON BETWEEN FORMS

Survival of crawlers in absence of plant hosts. Newly hatched crawlers were carefully placed in ¼ dram shell vials which were then immediately ringed at the lip with gelatine adhesive and covered with cigarette paper, which permitted exchange of atmospheric gases. This technique was patterned after that developed by Hansen and Snyder (1939). No host plant or food was available. A pre-test count eliminated dead or injured crawlers and counts of survivors were made after 24 hours under test conditions. Results of this test were evaluated after making three replications involving a total of nearly 10,000 crawlers.

Relative humidity within the range used in this test apparently was not as important a mortality-inducing factor as was temperature. Table I shows the differences between forms in survival at relative humidities of 40% and 80%.

TABLE I

DIFFERENTIAL IN RELATIVE CRAWLER SURVIVAL OF UNIPARENTAL AND BIPARENTAL FORMS OF OLEANDER SCALE AFTER 24 HOURS AT 80 PERCENT RELATIVE HUMIDITY AS COMPARED WITH SURVIVAL AT 40 PERCENT RELATIVE HUMIDITY[a]

TEMPERATURE F°	FOLD INCREASE IN SURVIVAL—80 PERCENT R.H. OVER 40 PERCENT R.H.	
	Uniparental form	Biparental form
65	1.1	1.2
70	1.4	1.3
75	2.0	1.4
80	8.0	2.0

[a]Survived at 40 percent R.H. = 1.0. No Host Plant or food available.

Crawler survival was somewhat greater at the higher humidities at all temperatures for both forms of oleander scale. This was particularly true with the uniparental form at the high temperature of 80° F.

Mortality caused by temperature differences was much greater than that as a result of differences in relative humidity. Figure 2 shows that at 80° F., for instance, virtually no survival occurs but that at 65° F. over 80% survival may be obtained. Survival was materially greater among individuals of the uniparental form, especially at 65° and 70° F.

Crawler settling and survival on host plant. Crawlers of both forms were brushed onto partially waxed lemons (described under paragraph referring to "plant hosts" and shown in fig. 1), and, during the period of settling and development, daily observations were made and results obtained after exposure to temperatures of 65, 70, 75, and 80° F. and to relative humidities of 40, 50, 60, 70 and 80% at each temperature. Results of this test were based on three replications involving a total of approximately 14,800 crawlers. Figure 3 shows the results of this test considering only the effects of the temperatures. To a more marked degree those in the previous test temperature appeared to have a greater effect on settling and survival than did the differences between humidities of from 40 to 80%. Results, therefore, have been averaged for all humidities at each temperature tested. Observations made during these tests revealed that although most of the crawlers settled, and constructed their wax covers, many of them failed to enter the second instar. Mortality after the second instar was negligible. It also appeared that crawlers tend to settle more slowly at the lower temperatures and at higher humidities, (especially biparental form crawlers), and that if they had not settled after 2 days most of them died. Those crawlers which did not settle soon after being placed on the lemons probably died from depletion of stored nutrient material and loss of moisture. More rapid settling at lower humidities is probably a survival response to loss of body moisture. The greater reluctance to settle on the part of biparental crawlers might be construed to mean that lemon is not so acceptable a host for this strain as it is for uniparental oleander scale.

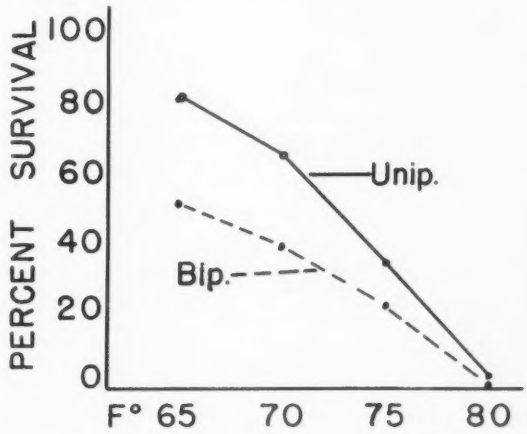

FIG. 2. Percent crawler survival in uniparental and biparental forms of oleander scale after 24 hours at various temperatures. Relative humidities of 40 to 80 percent averaged for each temperature. No host plant or food available.

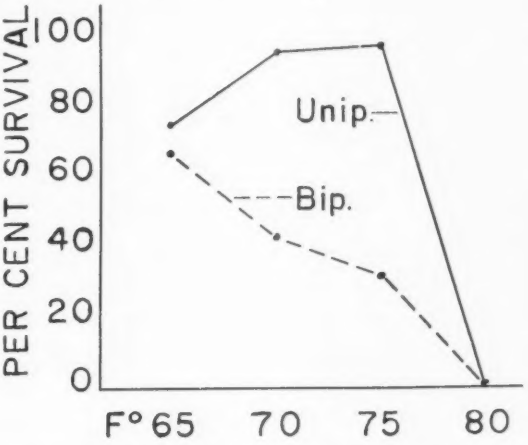

FIG. 3. Crawler survival in uniparental and biparental forms of oleander scale on green lemon fruits at various temperatures as measured by percent survival after 34 days. Relative humidities of 40 to 80 percent averaged for each temperature.

Differences in survival between forms were very striking in this test. Figure 3 shows that the greatest survival among the biparental form occurred at 65°F. but amounted to only 67.6%, whereas in the uniparental form the peak occurred at 75° F. and amounted to 98.0% survival. At 75° F. there was a differential survival of 64.8% in favor of the uniparental form.

Life cycle and progeny production. The comparison of life cycles and progeny production at various temperatures and humidities emerged as a continuation of the crawler settling and survival test just described, the survivors being used for measurement of the life cycle as well as progeny production.

Life cycle. After the males of the biparental form had emerged and had presumably mated with the females, they and all females in excess of about twenty per fruit were picked off the lemons. These remaining females were isolated from each other by means of a thin sticky barrier of commercial "Deadline" so that accurate individual records could be kept. The uniparental form was handled similarly. Thus in all, for each form, there were approximately twenty isolated adult females on each of ten lemons at temperatures of 65°, 70°, and 75° F., there having been no survival at 80° F.

The period from original crawler to new crawler production determined the length of the life cycles under the various conditions. Suffice it to say that the life cycles were nearly equal for both forms on green lemons, being 49, 62, and 86 days at 75°, 70°, and 65° F. respectively. The 10° F. difference between 75° and 65° F. is thus seen to have extended the life cycle 37 days. 75° F., therefore, would be by far the most efficient rearing temperature for mass culture inasmuch as the number of generations per year in the insectary is a prime consideration. It will be recalled that survival of the biparental form is very low at this temperature, hence the potential usefulness of this form is decidedly reduced.

Crawler production. Crawlers produced by the isolated females within the "Deadline" ring were removed and counted at regular intervals. Some crawlers became mired in the edges of the "Deadline" and were included among the progeny of the female scale closest to them. Counts of crawler production were discontinued when it was time for the second generation to begin emerging.

In addition to the total numbers of crawlers produced by the two forms of oleander scale, data were obtained on the average daily production of crawlers, longevity of the mother scales, number of days in crawler production, and age of the mother scales at the peak of crawler production.

These data are summarized in Table II. From this table it is evident that the two forms are very distinct biologically with respect to all phases of crawler production and longevity of the mother scales. The uniparental form was superior in progeny production and in all other responses at 70° and 75° F., and 75° F appears to be close to optimum. The uniparental form was markedly superior to the biparental strain at 75° F. Neither form was able to complete the life cycle at 80° F. constant. Only at the relatively low temperature of 65° F. was the biparental form superior in progeny production and other responses. This temperature appears to be close to the optimum for the biparental form; even so at 65° F. this form was not decidedly superior to the uniparental form. In addition, the life cycle is too long at this temperature to be of use in mass culture in the insectary. All these data indicate the uniparental form to be superior for use in the mass culture of *Aphytis* "A".

TABLE II

PROGENY PRODUCTION AND RELATED BIOLOGICAL RESPONSES ON GREEN LEMON FRUITS OF UNIPARENTAL FORMS OF OLEANDER SCALE AT VARIOUS CONSTANT TEMPERATURES[a]

AVERAGE PER FEMALE SCALE	TEMPERATURE IN °F.					
	UNIPARENTAL FORM			BIPARENTAL FORM		
	65°	70°	75°	65°	70°	75°
Longevity of mother scales (days)	148	108	93	131	95	75
Age of mother scale at first peak of progeny production (days)	102	75	60	95	72	62
Days elapsed between start of progeny production and first production peak	10.6	14.4	10.6	5.4	11.2	11.4
Number of days in production	58	48	38	50	33	23
Daily production of progeny	0.9	1.8	2.8	1.2	0.8	0.6
Total progeny produced	37	86	94	53	32	14

[a]Relative humidities of 40–80 percent averaged for each temperature.

Crossmating tests. No progeny were produced by twenty isolated unmated biparental females, and no male progeny were obtained after placing biparental males with uniparental females. Genetically, then, these forms appear to be completely isolated from each other even though they occur together in nature.

DISCUSSION

Data given in this paper show that under the name *Aspidiotus hederae* (Vallot) at least two biologically distinct forms coexist in nature. These forms are completely isolated reproductively inasmuch as one form (uniparental) does not produce males and the other form (biparental) requires fertilization for the production of any progeny. Morphological differences, if any, between females are cryptic because competent scale taxonomists have referred both forms to *Aspidiotus hederae*. Ferris (1938), however, has suggested that more than one species might be included under *A. hederae*. The conclusion seems inevitable that the two forms studied represent sibling species, as defined by Mayr (1942). Perhaps further morphological study will enable some qualified taxonomist to describe one of them as a new species.

SUMMARY

A uniparental and a biparental form of *Aspidiotus hederae* (Vallot) have been tested under controlled constant temperatures and humidities using green lemon fruit as the host. In the absence of plant hosts, crawlers of the uniparental form showed superior survival at 65°, 70°, and 75° F. Survival decreased from 65° to 75° F., and total mortality occurred rapidly with crawlers of both forms at 80° F. constant. Relative humidities of 80% increased crawler survival of both forms somewhat over relative humidities of 40% at temperatures of 65°, 70°, and 75° F. but delayed settling. In the presence of plant hosts survival of developing insects after 34 days at 70° and 75° F. was markedly superior in the uniparental form. No survival occurred at 80° F. constant. Duration of the life cycle was similar in both forms and was 75% longer at 65° F. than at 75° F. Average total progeny at 75° F. was 107 crawlers for the uniparental form and 15 crawlers for the biparental form. At 65° F., however, it was 37 crawlers for the uniparental form and 52 crawlers for the biparental form. Other biological responses were similarly distinct. 65° F. appeared optimum for the biparental form, whereas 75° F. appeared optimum for the uniparental form. Differential responses of the two forms plus genetical isolation were great enough to indicate that definite sibling species were involved. Practically all results indicated the uniparental form of oleander scale to be superior for use as a host in the mass culture of *Aphytis* "A".

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A COMPARISON OF TWO DIGESTIVE ENZYMES IN THE HOUSE FLY AND AMERICAN COCKROACH[1]

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Comparisons of digestive enzymes by previous workers on insects have dealt with the pH required for optimum activity and with substrate specificities. Such activity data do not prove identity of enzymes in different organisms but if a number of parameters are found to be similar then it becomes highly probable that the enzymes are similar in their essential features. In the present paper the effects of temperature on the activity of invertase and proteinase in adult house flies (*Musca domestica*) and American cockroaches (*Periplaneta americana*) have been compared. The work was done partly to compare another parameter for the similarity of these enzymes in several insects with those in other animals and in plants, and partly to obtain data for comparison with the temperature coefficients of other processes in these insects [study of the latter aspect is still incomplete and will be reported on later].

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MATERIALS AND METHODS

Invertase activity was determined at pH 6.0 using 0.2 molar sucrose (Pfanstiehl) as substrate, and measuring glucose production at 20 or 30 minute intervals by reacting with dinitrosalicylic acid reagent and reading with a Coleman spectrophotometer (Model No. 11) at 550 mμ (Sumner and Somers, 1953).

Proteinase activity was measured by the method of Tomarelli *et al.* (1949). The azoalbumin used as substrate was prepared by us from bovine plasma albumin (fraction V, Armour Company) by coupling with diazotized sulfanilic acid. Tests were run with 1.25% or 1.5% substrate concentrations at pH 7.8 and the various temperatures, aliquots being used for determinations for a period of 1–3 hours. Readings were made at 400 mμ in the spectrophotometer and compared with a standard curve. The proteinase activity is expressed in terms of the velocity constant *k* (Tomarelli *et al.*, 1949) calculated on the basis of 100 mg. tissue/hour.

For both enzymes, the supernatant from a centrifuged homogenate was used. For the cockroach, homogenates were made from midguts plus gastric caecae. For the house fly, homogenates were made from pooled midguts alone for the proteinase determinations, but from pooled midguts plus salivary glands for the invertase determinations. For both species the two sexes were measured separately.

The reactions as measured were linear with time up to an hour, and plots of rate versus enzyme concentration gave lines prolonging through the zero intercept. Also, plots of the log of initial concentration/log of final concentration against time gave straight lines indicating a first order reaction for the proteinase.

A test on the possible effect of microorganisms in the lumen of the gut was made with our American cockroaches. Few bacteria were to be seen in smears from midgut contents. Cockroaches fed antibiotics (Succinyl sulfathiazole plus terramycin HC1) and their guts tested for invertase activity 1–2 days later gave results similar to those obtained from ordinary individuals. Similar results were also obtained by adding the antibiotics to the sucrose substrate solution (sulfathiazole at 0.2 mg./ml., terramycin at 0.1 mg./ml. final conc.).

RESULTS

Invertase (sucrase, saccharase) activity was studied more intensively. As shown by Figure 1, there is no difference between the activity of invertase from flies and cockroaches, at least not below 40° C. The leveling off of activity in fly preparations above 40° could be due to any of several factors; it does not necessarily imply a difference between the enzymes. In preliminary determinations of this curve for flies more scatter of points was obtained but the increase with temperature was continuous up to 50° C. as it is here with cockroach preparations. Also, in some individual runs, the cockroach breis plateaued or fell off in activity above about 40° C. [Yeast invertase shows deviation above 35° C. according to Sizer (1943)].

Not only the kinetics of the reaction but also the average amount of activity per milligram of tissue is similar, as shown by numerous points falling on top of one another. This does not mean that there is no individual variation. The fly data are from pooled lots of 40–100 midguts plus salivary glands, and hence individual variation is averaged out. The cockroach data represent averages from 3–6 determinations on different individual midguts plus caecae. Individual variation in the cockroach was 7.5 X, *i.e.*,

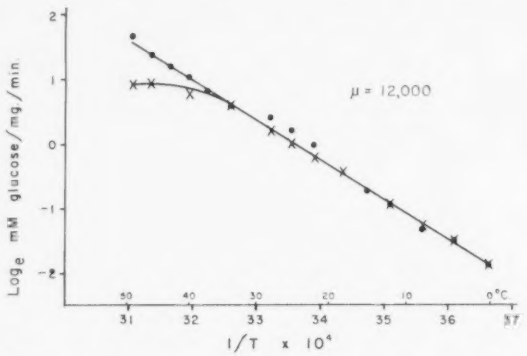

FIG. 1. Invertase activity as a function of temperature. Crosses represent data from adult house flies; solid circles represent data from adult American cockroaches. Data from the two sexes and from various ages combined.

the most active preparations were 7.5 X as active per milligram of tissue as the least active. In part this is related to recency of feeding as is known for several insect species (Day and Waterhouse, 1953). But high, medium and low activity preparations from cockroaches all gave similar μ values.

There is still considerable question as to how animal invertases compare with those from plant sources (Sumner and Somers, 1953). Most plant ones are fructosidases but some are glucosidases; animal ones tested have been found to be glucosidases. Activity with raffinose as substrate is the usual test for distinguishing between these two types of invertase (Neuberg and Roberts, 1946). No data on substrate specificity are available for cockroaches or flies. But we can note the close similarity of kinetics of the insect invertases to those from plant sources. Our value of $\mu = 12{,}000$ falls between the value of 11,000 reported for yeast invertase and the value of 13,000 reported for malt invertase (Sizer, 1943).

In the house fly, invertase activity was demonstrated to be present in both the salivary glands and the midgut. Presumably it occurs in the crop too but the finding of high blank values for crops (implying the presence of already inverted sugar from previous feeding) made it desirable to discard the crops during dissection.

Proteinase (protease) activity was studied less intensively, and the data do not fit quite as well onto straight lines on Arrhenius plots (Fig. 2). However as far as the data permit comparison, there are no evident differences between the proteinases of adult house flies and cockroaches. The slight difference in μ values calculated from the lines drawn is probably not significant. At least we do not feel that a difference of 1,000 cal./mol. is more than might be accounted for by experimental error in these particular tests. The calculated μ values are similar to those recorded for mammalian trypsin preparations (12,000–16,000; Sizer, 1943).

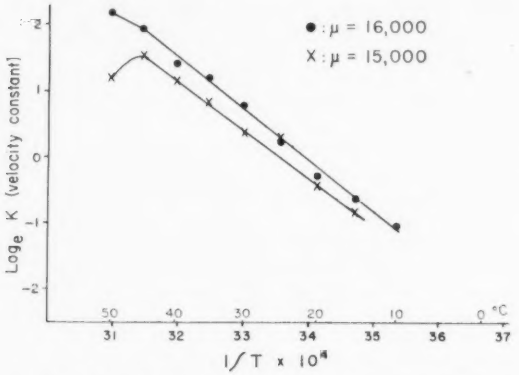

FIG. 2. Proteinase activity as a function of temperature. Crosses represent data from adult male house flies; solid circles represent data from adult American cockroaches (♂+♀).

The proteinase activity was low in both species. Values in Figure 2 are plotted as the log of K, the reaction velocity constant. To illustrate the rate of reaction in other terms, the values at 35° C. correspond to the digestion of 20–60 μg. protein/mg. tissue/hour (averaging about 30 μg. for the house fly, 35 μg. for the cockroach).

In contrast to invertase activity, proteinase activity in the adult house fly was negligibly low in the salivary glands.

The picture for these two digestive enzymes differs from the reports of various workers for muscle enzymes in the same species. With several muscle enzymes large sex differences have been reported in the American cockroach, and large age differences during the first week of adult life in the house fly. For invertase, there is no sex difference in the adult American cockroach, and neither a sex nor an age difference in house flies (tested 2–9 days of adult age). The situation is less certain with proteinase. Our determinations show 60% higher proteinase activity in male cockroaches and about 100% higher activity in female house flies, but these seeming differences may be related to feeding and other activities (Fisk and Shambaugh, 1952, 1954).

SUMMARY

1. American cockroach midguts and house fly midguts plus salivary glands possess similar levels of invertase activity. The activity gives temperature kinetic curves similar to those from yeast and malt invertase.

2. The cockroach and house fly also show similar temperature kinetics for proteinase. The μ values fall within the upper part of the range of values reported for mammalian trypsins.

3. Invertase is present in both the salivary glands and midgut of adult house flies, but proteinase is virtually absent from the salivary glands of this species.

4. Invertase did not show significant differences in level of activity correlated with either age or sex.

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Erratum

In the recently published paper, "A morphometric analysis of DDT-resistant and non-resistant house fly strains" (Ann. Ent. Soc. Amer., 48: 499–511, 1955) on page 500, column 2, paragraph 2, line 12, it is stated that NAIDM fly medium was used instead of the CSMA medium actually used. Manufacture of the former medium was discontinued after 1950.

On page 503, column 2, paragraph 2, rJK.g should read $r_{JK.g}$, and rOP.g should read $r_{OP.g}$.

A NEW SARCOPHAGID GENUS WITH DESCRIPTIONS OF FIFTEEN NEW SPECIES (DIPTERA)

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In the course of fly collecting on mountain summits in 1952, some of the commonest species taken were of the *Sarcophaga "sima-idonea* group." Fourteen species of this group were recognized in the summit material, of which nine were considered to be undescribed. This revision is based on that material, plus rather limited material from other sources, primarily the U. S. National Museum, the University of Michigan Museum, the Carnegie Museum, the Emory University Museum, the Chicago Natural History Museum, the American Museum of Natural History, the Snow Entomological Museum of the University of Kansas, the Museum of Comparative Zoology, and the Canadian National Collection. Valuable material was made available for study through the courtesy of Prof. Henry Dietrich and Dr. C. O. Berg, Cornell University, Mr. Wm. L. Downes, Ames, Iowa, Dr. F. M. Snyder, Baltimore, Md., and Mr. G. C. Steyskal, Grosse Ile, Mich. The late Professor P. W. Fattig, of Emory University, was also very helpful, and three more species were added to the Georgia list through his collecting. The writer is also indebted to the following persons for assistance in summit collecting: Mr. J. M. Seago, Mr. W. D. Sudia, Dr. H. D. Pratt, Dr. N. E. Good, and Mr. Charles Dunaphant.

Prof. H. J. Reinhard, College Station, Texas, kindly compared specimens with types in his collection and verified the author's belief that many of the species were new.

Fourteen figures were drawn by Mr. Chester J. Stojanovitch; the remainder were drawn by the author. All drawings were made by aid of a camera lucida from spread, dry genitalia which were not treated with KOH.

Idoneamima new genus

This genus is erected for species of the "*Sarcophaga sima-idonea* group," most of which trace to couplet 11, Group B, of Aldrich (1916). However, some species will key elsewhere because they have black genital segments or the hind tibiae nonvillous, and one, *montanensis* Hallock, has four, not three posterior dorsocentral bristles. *Idoneamima* differs from *Sarcophaga* in the restricted sense of Townsend (1938) and Rhodendorf (1937) by the distal segment of the penis having a single anterior process, whereas in *Sarcophaga* the anterior process is paired, the two parts being separated by a longitudinal, membranous groove. The most closely allied American genera are *Sarraceniomyia* Townsend (genotype *Sarcophaga sarraceniae* Riley) and *Bercaeopsis* Townsend (genotype *Sarcophaga tetra* Aldrich).

Most of the species of *Idoneamima* can be identified with certainty only by characters of the male genitalia. For this reason the following description of the external characters will not be repeated in the descriptions of the species.

Usually rather thinly pollinose, subshining species with thorax three-striped and abdomen with a changeable, checkered pattern dorsally. Agrees with *Sarcophaga* in the broad sense employed by many authors.

Male: Head grey pollinose, about two-thirds as long as high; vibrissal axis one-eighth shorter than antennal axis; eye large; cheek less than one-third of eye height. Outer vertical bristles not developed; ocellar bristles present; frontal rows of ten to thirteen pairs of bristles, strongly divergent anteriorly and reaching middle of second antennal segment; front at narrowest 0.116 to 0.191 of head width; proclinate fronto-orbitals absent, the reclinate one pair. Antennae black, the third segment twice the length of the second; arista with second segment as long as its diameter, third segment swollen on basal third to fifth, long- or medium-plumose on basal half or three-fifths. Clypeus shallowly depressed; epistoma warped forward, situated between the vibrissae. Parafrontals with one row of fine, black hairs; parafacials similar, but the lowermost two to five hairs abruptly larger, bristle-like. Cheeks black-haired; occiput with three or more rows of black postocular hairs, but with some pale hairs surrounding and below the foramen and upon the metacephalon, sometimes completely covering the latter. Palpi black, slender, as long as antennae; haustellun a fifth shorter than palpi.

Thorax: Dark grey, pollinose, with three black stripes and a pair of small submedian streaks on the prescutum. Chaetotaxy: acrostichals 0:1; dorsocentrals 4:3 (4:4 in *montanensis*); intraalars 1:2, none near the suture; supra-alars 2:3; humerals 3; notopleurals 4; posterior callus 2; sternopleurals 3; propleurae bare; prosternum pilose except in *carinata* and most *tarsata;* metasternum pilose; hind coxae pilose on hind margin; infrasquamal setulae present; postalar declivity setulose; scutellars 2 marginal, 1 apical, cruciate, 1 weak discal.

Abdomen: Dark grey, pollinose, with changeable checkered pattern dorsally and three longitudinal stripes in posterior view; color wholly

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black (including genital segments) to red with a middorsal dark stripe; fourth tergite with a marginal row of bristles, third tergite with median marginals or an interrupted marginal row; second tergite without median marginals except as noted in the individual descriptions. Sternites 1–4 with fine hairs only, the fifth deeply cleft, V- or U-shaped, with hairs or fine bristles on the margins of the cleft.

Genital segments: Red or black, usually the first pollinose, sometimes both pollinose and rarely both shining; the first segment with or without an interrupted marginal row of weak or strong bristles; the segments hairy and of about equal length; spiracle 6 located in the membrane preceding the first segment and spiracle 7 located on the segment. Forceps entirely black or reddish basally, joined for about three-quarters of their length, in lateral view nearly straight or moderately curved, with sides nearly parallel for most of their length, apex with a small point which may be "apical" (fig. 1) or "internal" (fig. 1A). Forceps clad with rather sparse and fine hairs, which subapically often occur as spinules. Accessory plate setose, flat, usually subtriangular or semicircular in lateral view. Claspers variable, equal in length or the anterior pair longer. Posterior clasper less than a third as long as penis, curved apically, with a minute subapical hair. Anterior clasper with outer margin often conspicuously swollen basally in ventral view, the inner margin often thin and curled, showing as an "internal margin" in lateral view. Penis two-segmented, the basal stalk sclerotized and shallowly grooved along hind margin, broadly membranous anteriorly and on the sides; the distal segment moderately small to large and globose, terminating in an apical "claw" which usually encloses some median rods, the body of the segment hollowed out from the anterior side, the the side pieces often extensively membranous. Base of the distal segment with an "anterior process", which is very variable in shape, with or without a median keel and lateral sheath or plume, the apex often notched or bifurcate, as seen in anterior view.

Wings: Hyaline, rarely infuscated; veins brown, vein 1 bare, vein 3 with setules half way or more to the cross vein; costal spine vestigal except in *tarsata* and *bicolor;* costal segments 1 to 6 in the ratio 4, 6.5, 4.6, 8.5, 2.9 and 1, respectively, in the genotype. Squamae white; epaulet black; basicosta white.

Legs: Black (reddish in *tarsata*); hind tibiae usually sparsely villous but nonvillous in two species; midfemur without a comb. Claws and pulvilli much longer in male than in female, the male claws twice as long as the fourth segment of the tarsus.

Female: Similar to the male, except for the usual sexual differences (front broad, about a third of head width, with two pair proclinate fronto-orbital bristles, apical scutellar bristle lacking). Venter of the abdomen usually shining with thin, uniform pollen but strongly pollinose in the genotype and several other species. Genital segments reddish or black, the first genital tergite pollinose or shining, divided middorsally, with a marginal row of rather weak bristles; genital sternites not broader than the preceding ones. Tarsal claws slightly longer than the fourth segment of the tarsus. Females have been rarely captured, and it has been nearly impossible to associate them with their respective males except when taken in copulation, or in the case of striking color characters, as in *I. tarsata* (Ald.) and *bicolor* n. sp.

Biology: Little is known of the biology of this group of insects, but they may all be parasitic in habits. *I. parallela* (Ald.), *mimoris* (Reinh.) and *helicivora* n. sp. have been reared from snails; *I. sutilis* (Reinh.), previously reported as *sima*, was reared from *Curculio caryae* larvae; *I. sabroskyi* n. sp. is probably parasitic on the katydid, *Pterophylla camellifolia*. Specimens identified for S. W. Bromley as *sima* group females were later reported by Dr. Bromley as attacking the Carolina locust, *Dissosteira carolina*, while in flight.

Most of the material on which this revision is based was collected by the writer and fellow workers on Georgia mountain summits. In the 1952 season, 55 summit net collections yielded a total of 1,045 males and 17 females, whereas by trap only 13 males and 10 females were taken. In Communicable Disease Center fly trap collections, four species have been identified; they are *sima* (Ald.), *mimoris* (Reinh.), *parallela* (Ald.), and *pratti* n. sp. Special trapping in the environs of Stone Mountain, Georgia, April and May, 1952, yielded 5 *sima* males and 20 *sima* group females from a total of nearly 15,000 flies. In Charleston, West Virginia, 377 fly trap collections in 1950 yielded 10 male and 46 female *sima* group specimens.

Distribution: The species appear to be confined to eastern United States and Canada. The greatest concentration of species was at Rabun Bald, Georgia, where 13 of the 14 Georgia summit-occurring species were collected. The fourteenth species, *sima*, is widely distributed and its absence at Rabun Bald is not understood.

The genotype of *Idoneamima* is *I. sabroskyi* n. sp. The following keys are presented to separate the species known to the author, plus a few allied forms. Twp species, *Sarcophaga acadiana* Reinh. and *S. elanis* Reinh., are evidently members of this group. They have not been studied by the author, so are not placed in the key.

A KEY TO MALE *IDONEAMIMA* AND RELATED FORMS IN EASTERN NORTH AMERICA

1. Both genital segments pollinose dorsally 2
   Both genital segments entirely shining, non-pollinose 11
   First genital segment pollinose, the second shining. 12
2. At least the second genital segment red 3
   Genital segments black 7

3. Claw of penis strongly compressed....**I. pratti** n. sp.
Claw of penis not compressed.....4
4. Anterior process of penis, in ventral view, with two oval lobes connected by a thin margin; claw of penis very broad.....**I. smithi** n. sp.
Anterior process with the lobes broadly connected at their base; claw of penis narrower.....5
5. Hind tibia densely villous.....**I. fortisa** (Reinhard)
Hind tibia moderately villous.....6
6. Anterior clasper not emarginate apically.....**I. helicivora** n. sp.
Anterior clasper emarginate apically.**I. beameri** n. sp.
7. First genital segment with a marginal row of bristles.....**Sarcophaga pulla** (Aldrich)
First genital segment with marginal row vestigal[2] or absent.....8
8. Anterior clasper with internal margin, in lateral view.....9
Anterior clasper without internal margin.....10
9. Internal margin narrow; accessory plate produced anteriorly.....**I. morosa** (Aldrich)
Internal margin strong; accessory plate produced ventrally.....**I. monticola** n. sp.
10. Accessory plate elongate oval; penis with concealed median rods.....**I. pleomenda** (Reinhard)
Accessory plate subtriangular; penis with exposed median rods.....**I. paulina** (Hall)
11. Second genital segment red; three posterior dorsocentrals.....**I. idonea** (Aldrich)
Second genital segment black; four posterior dorsocentrals.....**I. montanensis** (Hallock)
12. First genital segment with a marginal row of bristles.....13
First genital segment with marginal row absent or vestigal;.....26
13. Abdomen red, at least on sides and venter.....14
Abdomen black, at least on first three segments...15
14. Legs black; anterior clasper swollen at base, in ventral view.....**I. bicolor** n. sp.
Legs reddish; anterior clasper parallel-sided.....**I. tarsata** (Aldrich)
15. Anterior clasper strongly or abruptly widened at base, in ventral view.....16
Anterior clasper not strongly widened at base.....20
16. Sides of forceps concave and bare near middle of length.....17
Sides of forceps convex and setuled along middle of length.....18
17. Hind tibia non-villous; forceps constricted at middle, with sides concave beyond the constriction.....**I. parallela** (Aldrich)
Hind tibia villous; forceps concave before the middle, which is narrowed but not constricted.....**I. carinata** n. sp.
18. Anterior clasper gradually broadened to base.....**I. sabroskyi** n. sp.
Anterior clasper strongly widened laterally at base.19
19. Penis with a hood-shaped process arising from the claw.....**I. snyderi** n. sp.
Penis claw without a hood-shaped process.....**I. sima** (Aldrich)
20. Anterior clasper tapering from base, narrowest on apical half, in ventral view.....21
Anterior clasper narrowest sub-basally, or with sides parallel.....22
21. Accessory plate less than twice as long as wide.....**I. fattigi** n. sp.
Accessory plate more than twice as long as wide.....**I. acrophila** n. sp.
22. Hind tibia densely villous.**Bercaeopsis tetra** (Aldrich)
Hind tibia sparsely villous.....23
23. Claw of penis small, not especially compressed.....**I. mimoris** (Reinhard)
Claw of penis large, compressed.....24
24. Accessory plate more than twice as long as wide.....**I. rabunensis** n. sp.
Accessory plate not more than twice as long as wide.....25
25. Claw of penis elongate, acuminate, in lateral view.....**I. ontariensis** (Hall)
Claw of penis short, stout.....**I. sutilis** (Reinhard)
26. Anterior clasper abruptly or distinctly widened at base.....27
Anterior clasper slender, parallel throughout, or nearly so.....30
27. Hind tibia non-villous.....**I. sudiai** n. sp.
Hind tibia villous.....28
28. Anterior claspers strongly convergent apically.....**I. seagoi** n. sp.
Anterior claspers parallel apically, or nearly so....29
29. No median marginals on second abdominal segment.....**I. hesterna** (Reinhard)
A strong, erect pair of median marginals on second abdominal segment.....**I. louisianensis** n. sp.
30. Forceps with a row of barbs on lateral margins.....**Sarraceniomyia sarraceniae** (Riley)
Forceps without such row of barbs.....31
31. Forceps separated on apical 0.19 of length.....**I. mimoris** (Reinhard)
Forceps separated on apical 0.30.....**I. epitheca** (Reinhard)

[2]The marginal row of bristles is considered vestigial if the bristles are weaker than the vestiture of the second genital segment.

ALTERNATE KEY TO MALE *IDONEAMIMA* AND RELATED FORMS IN EASTERN NORTH AMERICA

1. Forceps with point apical in position, or nearly so.. 2
Forceps with point internal, nearly in line with the internal margin.....13
2. Hind tibia villous.....4
Hind tibia non-villous, but may have two to seven fine, suberect, posteroventral bristles which may be confused with villosity.....3
3. Forceps slightly bisinuous in lateral view, not constricted.....**I. sudiai** n. sp.
Forceps bent slightly beyond middle, in posterior view constricted at this point.**I. parallela** (Aldrich)
4. Anterior clasper, in lateral view, with an expanded internal margin.....5
Anterior clasper not expanded internally.....9
5. Penis claw very elongate, compressed; anterior process terminating in a pair of points.**I. pratti** n. sp.
Penis terminating in a moderately small claw.....6
6. Anterior clasper broadest apically, in ventral view.....**Bercaeopsis tetra** (Aldrich)
Anterior clasper not broadest apically.....7
7. Accessory plate with the anterior margin longest, the apex directed forward; anterior clasper with narrow internal margin; genital segments black.....**I. morosa** (Aldrich)
Accessory plate with posterior margin longest, the apex directed ventrally; anterior clasper broadly margined internally; genital segments black or red.....8
8. Penis with anterior process strongly keeled at base; genital segments black.....**I. monticola** n. sp.
Anterior process without median basal keel; genital segments red to black, usually the second segment is red.....**I. seagoi** n. sp.
9. Penis with a pair of flattened processes which nearly conceal the terminal claw...**I. fattigi** n. sp.
Penis with a conspicuous hood-shaped process arising from the claw.....**I. snyderi** n. sp.
Penis without such processes or hood, the claw exposed.....10
10. Genital segments black; anterior clasper very thin, strongly curved.....11
At least second genital segment red; anterior clasper stouter, less strongly curved, as seen in lateral view.....12
11. Anterior process closely appressed to distal segment of penis, terminating in two backward-directed points.....**I. pleomenda** (Reinhard)
Anterior process less closely appressed, terminating

in two forward-directed, oval, flattened lobes. ..... **I. paulina** (Hall)

12. Anterior process of penis, in ventral view, with two oval lobes connected by a thin margin; claw of penis broad ..... **I. smithi** n. sp.
Anterior process with the lobes broadly connected at their base; claw of penis narrower.... ..... **I. fortisa** (Reinhard) and **I. helicivora** n. sp.

13. Anterior process of penis small, oval in shape. ..... **Sarcophaga pulla** (Aldrich)
Anterior process small, oval at base, tapered to a point ..... **I. hesterna** (Reinhard)
Anterior process large, concealing tip of claw in lateral view 14
Anterior process moderate in size, not as above.... 16

14. Both genital segments shining; distal segment of penis deeply excised between claw and side pieces. 15
First genital segment pollinose; distal segment of penis not deeply excised..... **I. acrophila** n. sp.

15. Four posterior dorsocentral bristles; genital segments black; at base of excision is a small, peg-like spine..... **I. montanensis** (Hallock)
Three posterior dorsocentrals; genital segments red; no such spine at base of excision. **I. idonea** (Aldrich)

16. Penis with huge, compressed, apical claw which bears a pair of flattened, curved, lateral arms..... **I. epitheca** (Reinhard)
Penis with elongate, finger-shaped, blunt claw ..... **I. sabroskyi** n. sp.
Penis with apical claw smaller, if elongate then very attenuated..... 17

17. Anterior process of penis with long, incurved arms, very thin in posteroventral view..... 18
Anterior process without long, thin, incurved arms. 21

18. Claw of penis very elongate, acutely tapered. ..... **I. ontariensis** (Hall)
Claw, stout, blunt..... 19

19. Abdomen black, except for hind margin of fourth tergite and genital segments... **I. sutilis** (Reinhard)
Abdomen in great part reddish, at most the dorsum of tergites 1 to 3 black..... 20

20. Legs (including coxae but excluding tarsi) reddish; wings usually hyaline..... **I. tarsata** (Aldrich)
Legs black, excepting sometimes the middle and hind femora; wings usually heavily infuscated along the veins..... **I. bicolor** n. sp.

21. Claspers subequal in length..... 22
Claspers unequal, the anterior longer..... 25

22. Anterior clasper without internal margin..... 23
Anterior clasper with internal margin..... 24

23. Forceps straight, evenly convex laterally..... ..... **I. mimoris** (Reinhard)
Forceps crooked, with a concavity on the sides before the middle, the concavity bordered by a strong ridge..... **I. carinata** n. sp.

24. Anterior clasper broadest apically in ventral view, with strong internal margin in lateral view ..... **Bercaeopsis tetra** (Aldrich)
Anterior clasper broadest basally, with narrow internal margin..... **I. sima** (Aldrich)

25. Anterior clasper not emarginate at apex..... 26
Anterior clasper emarginate at apex..... 27

26. Genital segments black.... **I. pleomenda** (Reinhard)
At least the second genital segment red.... ..... **I. helicivora** n. sp.

27. Anterior clasper with strong lateral swelling basally. 28
Anterior clasper without strong lateral swelling basally..... 29

28. No median marginal bristles on second visible tergite..... **I. beameri** n. sp.
A strong pair of median marginal bristles on second visible tergite..... **I. louisianensis** n. sp.

29. Anterior clasper, in lateral view, widened along entire length; claw of penis strongly compressed. ..... **I. rabunensis** n. sp.
Anterior clasper narrowed along middle of length; claw of penis not compressed..... ..... **Sarraceniomyia sarraceniae** (Riley)

Idoneamima sabroskyi new species

(FIG. 2, 2A, 2B)

Sarcophaga cramptoni Parker manuscript name.

Length 9–15 mm. A large species, widely distributed in the eastern States. Specimens have been misidentified as *idonea* at the U. S. National Museum, but the two species may easily be separated according to the keys.

Male: Front at narrowest 0.171 to 0.191 of head width (avearage 0.182 of five). Tergite 4 wholly black or with hind margin red in about ten percent of the material. Genital segments reddish yellow, or the first sometimes darkened; first segment pollinose, with an interrupted marginal row of eight bristles; second segment shining. Forceps black, in profile straight and parallel-sided on basal 0.8, thence curved and tapered to apex, point internal. Accessory plate flat, red, triangular. Claspers unequal, the anterior clasper longer, with internal margin on apical half as seen in lateral view. In ventral view the anterior claspers are gradually tapered from their bases, parallel on basal half, thence strongly bowed, convergent, apically. Distal segment of penis large, globular, with an elongate, moderately compressed, blunt apical claw which is parallel-sided in lateral view and encloses two rods with hooked apices; anterior process bilobed, in lateral view subequal in size to the claw and curving to touch it, a membrane with feathered margin at either side of its base.

Female: Front at narrowest (vertex) 0.283 to 0.300 of head width. Venter of abdomen with strong, grey, variegated pollinosity. Hind margin of tergite 4 red; genital segments red, the first genital tergite shining, divided middorsally, with a marginal row of weak bristles; spiracle 6 in the membrane, spiracle 7 on the segment. Genital sternites rectangular, narrow, yellow pollinose, the sixth with a marginal row, the seventh bare, the eighth with a small pair of bristles.

Holotype male and *allotype* female in copulation, Kennesaw Mountain, Cobb County, Georgia, June 15, 1952, Dodge, Seago and Sudia. Type No. 62792, U. S. National Museum.

Paratypes: One hundred nine males, Kennesaw Mountain, same date as type pair; 373 males, same locality, June 12 to September 10, 1952, and April 24 to May 28, 1953, various collectors; 42 males, one female, Stone Mountain, DeKalb County, Georgia, May 2 to June 22, 1952, and April 22 to May 2, 1953, Dodge and Seago; 69 males, two females, Rabun Bald, Rabun County, Georgia, June 20 September 24, 1952, and May 12, 1953, Dodge, Seago and Sudia; two males, Tray Mountain, Towns and White Counties, Georgia, May 13, 1953, H. R. Dodge; 31 males, Mt. Enotah, Towns and Union Counties, Georgia, July 13 to August 20, 1952, Dodge, Sudia and Seago; one male, Chenocetah Mountain, Cornelia, Baldwin County, Georgia, July 23, 1952, J. M.

Seago; one male, Blood Mountain, Union County, Georgia, August 1, 1952, H. R. Dodge; one male, Wayah Bald, Macon County, North Carolina, July 27, 1952, H. R. Dodge; 19 males, Black Mountain, Union and Lumpkin Counties, Blood Mountain, Blue Mountain, Towns and White Counties, Fort Mountain, Murray County, Kennesaw Mountain, Rabun Bald, Stone Mountain, Tray Mountain, various dates, P. W. Fattig; one male, Pinnacle Mountain, South Carolina, September 20, 1929, O. L. Cartwright; three males, Sugar Grove, Ohio, April 10, 1928, D. G. Hall; two males, Columbus, Ohio, J. S. Hine; two males, Wellesey, Ohio, 1909, J. D. Tothill; one male, Oakland County, Michigan, July 4, 1924, A. W. Andrews; 10 males, Ann Arbor, Washtenaw County, Michigan, July 27 and August 1, 1927, N. K. Bigelow; one male, St. Ignace, Mackinac County, Michigan, September 19, 1929, S. Moore one male, Cheboygan County, Michigan, July 27, 1932, Gertrude Grant; one male, Thatcher Park, New York, May 27, 1923 (predet. "*sima*" by Hallock and "near *idonea*" by Roback); one male, Mt. Hurricane, Essex County, New York, June, 1939, R. C. Shannon; five males, Lynn, Massachusetts, August 25, F. B. Lowe; one male, Henry County, Iowa, May 2, 1941, M. Jenness. *S. cramptoni*, holotype male and allotype female, Mass.: Melrose Highlands, May 17, 1908, C. H. T. Townsend, and Lunenburg, May 12, 1914, respectively. Type No. 19170, U. S. National Museum; one male, Campbelltown, N. B., Canada, June 18, 1915.

Biology: The late P. W. Fattig has one record of "*S. idonea* Aldrich" (ident. D. G. Hall) reared from the katydid, *Pterophylla camellifolia*, at Atlanta, Georgia, August 24, 1936. The fly on which this record is based can not be found, but in all probability it should be referred to *sabroskyi*.

Of 647 males and four females recorded from Georgia mountain summits, only one mated pair was secured and only one male and two females were taken by fly trap. It is a very common species in summit net collecting, yet no specimen has ever been netted elsewhere in Georgia, to my knowledge. The probable host insect is not confined to mountainous environs, and *sabroskyi* should be looked for in the forest canopy where the host insect occurs.

Variation in coloration has already been mentioned in the description. In chaetotaxy, ten of 135 specimens had an extra bristle between the

TABLE I

Information on species of IDONEAMIMA

Species	Known No. Specimens		Mode of Colln.		Male Frontal Width	Hind Tibia Villous	Male Genital Characters: (GS = genital segments)							
							Color of GS[1]	Pollinosity		Marg. row of 1st GS[2]	Ant. Proc. Penis		Anterior Clasper[3]	
	Male	Female	Net: Summits	Fly Trap				1st GS	2nd GS		Keel	Sheath		
sabroskyi	679	5	652	2	0.182	+	R	+	0	+	0	+	b	m
acadiana	1	0	0	0	?	+	R	+	0	?	?	+	?	M?
acrophila	72	0	72	0	0.153	+	R	+	0	w	+	+	11	m
beameri	1	0	0	0	.166	+	R	+	+	v	0	+	B	0
bicolor	15	120	0	133	0.134	+	R	+	0	+	0	0	B	M
carinata	1	0	0	0	0.160	+	R	+	0	w	+	+	B	m
elanis	1	0	0	0	?	+	B	+	+	?	?	?	?	?
epitheca	3	0	2	0	0.145	+	R	+	0	0	0	+	11	m
fattigi	88	0	88	0	0.168	+	R	+	0	++	+	+	b	0
fortisa	2	0	0	0	0.182	+	R	+	+	v	0	+	B	0
helicivora	54	1	53	0	0.175	+	R	+	+	v	0	+	B	0
hesterna	11	1?	6	1	0.159	+	R	+	0	v	0	0	b	0
idonea	5	0	0	0	0.170	+	R	0	0	+	0	+	B	0
louisianensis	1	0	0	0	0.138	+	B	+	0	0	0	0	B	M
mimoris	20	1?	0	1	0.170	+	R	+	0	w	0	+	11	0
montanensis	1	0	0	0	0.177	+	B	0	0	+	+	+	?	m
monticola	123	2?	125	0	0.145	+	B	+	+	0	+	+	b	m
morosa	8	1	0	0	0.185	+	B	+	+	0	+	+	b	m
ontariensis	12	0	0	0	0.132	+	R	+	0	+	+	0	A	0
parallela	41	2?	0	9	0.156	0	R	+	0	w	+	+	B	m
paulina	5	0	0	0	0.177	+	B	+	+	0	0	+	b	0
pleomenda	35	0	34	0	0.173	+	B	+	+	0	0	0	b	0
pratti	3	0	2	1	0.152	+	R	+	+	0	0	+	b	M
rabunensis	84	0	84	0	0.145	+	R-B	+	0	w	+	0	A	M
seagoi	253	0	252	0	0.154	+	R-B	+	0	v	0	+	b	M
sima	100	2	80	16	0.147	+	R	+	0	w	+	+	B	M
smithi	1	0	0	0	0.190	+	R	+	+	0	0	+?	b	m
snyderi	1	0	0	0	0.176	+	R	+	0	+	0	+?	B	0
sudiai	13	0	13	0	0.161	0	R	+	0	v	+	0	B	0
sutilis	254	1	245	0	0.127	+	R	+	0	+	+	0	b	M
tarsata	14	14	0	0	0.149	+	R	+	0	+	0	0	11	M

[1]Black (B) or Red (R). "Red" indicates all or partly red; the first GS may be black.

[2]+ or ++ indicates strong or very strong bristles; w indicates weak bristles, no larger than the hairs of the 2nd GS; v indicates vestigal and O indicates no differentiated bristles.

[3]The first column indicates width of clasper, in ventral view; widest at base (B, b), apex (A), or parallel (11). The second column indicates presence or absence of an "internal margin" (M, m or O), in lateral view. Capitol versus small letters denote relative degree of development in each case.

usual first and second posterior dorsocentral bristle in one or both rows, and in several this bristle was nearly as large as the first bristle. One also had a large bristle midway between the usual second and third bristle, thus having five posterior dorsocentral bristles on the left side. One specimen had four sternopleural bristles on one side.

Idoneamima acrophila new species
(FIG. 4)

Length 9–13 mm.

Male: Front at narrowest 0.143 to 0.160 of head width (average 0.153 of five). Abdomen black. Genital segments red, the first pollinose, sometimes infuscated, with an interrupted marginal row of six to eight weak bristles; the second segment shining. Forceps black, separated on nearly the apical third, in lateral view slightly angled beyond middle, the apical part rather slender, with point internal in position. Accessory plate red, flattened, its hind margin straight and anterior margin evenly curved. Claspers dark brown to black, the anterior pair longer, with internal margin, in ventral view only slightly swollen externally at base, the apices convergent. Distal segment of penis large, with a prominent median ridge posteriorly at base, the apical claw slender and curved forward, its apex and the median rods concealed by the anterior process. Anterior process as large as the accessory plate in lateral view; from its base, on each side, a triangular sheath with a sharp, free apex and thin, whitish, feathered outer margin; a sclerotized median keel on its basal half; beyond this, in anterior view, the anterior process cleft, the margins of the cleft thin and whitish.

Female: Unknown.

Holotype: Male, Rabun Bald, Rabun County, Georgia, August 2, 1952, H. R. Dodge. Type No. 62783, U. S. National Museum.

Paratypes: Fifteen males, same data as holotype; 30 males, same locality, July 12 to September 24, 1952, Dodge and Good; one male, same locality, May 12, 1953, H. R. Dodge; 11 males, same locality, June 13, 1954, H. R. Dodge; one male, Tray Mountain, Towns and White Counties, Georgia, September 18, 1952, P. W. Fattig; one male, Grassy Mountain, Murray County, Georgia, July 20, 1951, P. W. Fattig; 12 males, Wayah Bald, Macon County, North Carolina, July 27, 1952, Dodge and Good.

Variation: The metacephalon has four or five black hairs on the anterior margin to the anterior half black-haired. The first genital segment and tergite 4 are usually red apically, sometimes vaguely or narrowly so. Of 61 specimens only one has the first genital segment entirely red, two have this segment entirely black; seven have tergite 4 black and the first genital segment red or partly red. In chaetotaxy, one has a small bristle between the first two posterior dorsocentral bristles; two have one median marginal bristle on tergite 2; one has a median row on tergite 3.

Idoneamima bicolor new species
(FIGS. 5, 5A, 5B, 5C)

Length 5.5–8.5 mm.

Male: Front at narrowest 0.127 to 0.140 of head width (average 0.134 of five). Legs black, or with the middle and hind femora reddish. Wings more or less infuscated; costal spine small but distinct. Abdomen reddish, at least on venter, usually upon the sides, and rarely the black is reduced to a narrow dorsal stripe on the first three segments, or completely absent. Genital segments red, the first pollinose and with a marginal row of eight bristles, the second shining. Forceps red on basal half, separated on apical 0.27 of their length, in lateral view nearly straight, tapering apically, the point internal. Accessory plate flat, shining, subtriangular, the hind margin nearly straight. Claspers unequal, the anterior pair longer. Anterior claspers with strong, dark internal margin; in ventral view parallel, abruptly broadened laterally and widest at base, thence narrowest, gradually widening on apical half. Penis with rather short basal stalk, the distal segment large, with apical claw large, stout, pointed, not compressed. Anterior process well separated from the distal segment in lateral view, the base without a sheath or keel but with a transluscent "window"; in anterior view Y-shaped, the arms of the Y are very thin and curved when seen in posteroventral view.

Female: Similar to the male except for the usual sexual differences. Front at narrowest (vertex) 0.265 to 0.284 of head width; wings usually more heavily infuscated.

Holotype male and *allotype* female, Chatham County, Georgia, August 27–31, 1951, H. R. Dodge, fly traps. Type No. 62785, U. S. National Museum.

Paratypes: Five males, 13 females, same data as holotype; eight males, 106 females, Chatham County, Georgia, August 8 to November 18, 1952, J. W. Kilpatrick; 1 male, "Georgia, C. V. Riley Colln."

Variation: Some teneral specimens have the legs quite reddish but the coxae and tibiae are darkened. Variation in coloration of the abdomen and wings is mentioned in the description.

This species is very similar to *tarsata*, but differs by the darker legs, smaller costal spine, and in structure of the anterior clasper. Both species are unusual in this genus by their reddish abdominal coloration, but their genitalia show them to be closely allied to *sutilis*.

Idoneamima beameri new species

Length 8 mm.

Male: Genital segments reddish, pollinose, the first with an interrupted row of eight vestigal

bristles. Forceps reddish, darker apically, separated on apical fourth of their length; in lateral view straight, with point internal. Accessory plate reddish, flat, subtriangular, the hind margin rounded on apical third. Claspers unequal, the anterior pair longer, parallel, each with a strong lateral swelling basally and with an internal margin which is continued to the apex, the apex emarginate. Penis with long basal stalk which bears a deep median groove posteriorly. Distal segment of penis moderate in size, with apical claw short, curved forward, not compressed; anterior process nearly as large as the basal piece in lateral view, without keel, in anterior view Y-shaped.

Female: Unknown.

Holotype male, Montgomery County, Kansas, 798 feet, 1916, R. H. Beamer, in Hall collection. Type No. 62784, U. S. National Museum.

This species is very close to *helicivora*, differing primarily in the emarginate apex of the anterior clasper.

Idoneamima carinata new species

(Figs. 6, 6A, 6B, 6C, 6D)

Length 9.5 mm.

Male: Front at narrowest 0.160 of head width. Prosternum bare. Hind margin of fourth abdominal segment red; genital segments red, the first pollinose and with a marginal row of six weak bristles, the second segment shining. Forceps red basally, in posterior view with strongly converging carinae at middle of length, thence the sides are bare and concave to the apical third, which is densely clad laterally with stubby hairs; forceps separated on apical third of their length; in lateral view the carina and concavity are well-marked, the apical fourth bent, the point internal. Accessory plate red, flat, subtriangular, over twice as long as wide, the posterior margin nearly straight. Claspers equal, the anterior pair without internal margin, strongly bent on apical half, in ventral view parallel, the apices slightly converging. At the base of the anterior clasper, a distinct lateral protuberance with rounded apex. Penis with rather small, compact distal segment, the claw small, strongly bent forward, broad at base, acute apically. Anterior process hugging the body of the segment, with a weak keel extending to the apical lobes, which are sclerotized and broadly joined; the apex very shallowly incised in anterior view, a membranous sheath on either side at the base of the anterior process.

Female: Unknown.

Holotype male, Columbus, Ohio, J. S. Hine. Type No. 62786, U. S. National Museum.

The carinate forceps are very distinctive in this species.

Idoneamima epitheca
(Reinhard), new combination

(Fig. 7)

Sarcophaga epitheca Reinhard, 1952, Canad. Ent. 84: 143–144.

Length 10.5 to 11 mm.

Male: Front at narrowest 0.143 to 0.147 of head width. First genital segment pollinose, black, without a marginal row of bristles; second segment dark red, shining. Forceps black, slightly separated on nearly the apical third, in lateral view essentially straight but with irregular margins, tapering on the apical fifth to the point, which is internal in position. Accessory plate dark brown, triangular, slightly concave over much of its surface, with an umbone sub-basally. Claspers dark brown, the anterior pair longer, with internal margin and emarginate tip; in ventral view only slightly swollen laterally at base, the apices not convergent. Penis with stalk completely sclerotized on basal half; distal segment large, very distinctive, with the apical claw huge, compressed, with lateral ribs along hind margin and apex truncate, with a pair of curved lateral arms at the inner margin of the truncature. Anterior process not bifid, but with apex broad and bisinuous in anterior view; lateral sheath thin, brown.

Female: Unknown.

Holotype male, Great Smoky Mountain National Park, North Carolina, August 13, 1934, in Reinhard collection; not seen by the author.

EXPLANATION OF PLATE I

The figures were drawn by aid of a camera lucida from dry specimens and, unless otherwise stated, are left lateral views of the genital composite. Figures 2, 4, 7–11, 13, 15, 17, 19, 23, 26, and 27 were drawn by Chester J. Stojanovitch.

Fig. 1. Diagram of genital composite, left lateral view. Membranous areas are stippled. 2GS, second genital segment; AC, anterior clasper (Im, internal margin); AP, accessory plate; F, forceps (p the point, apical in position in fig. 1, internal in position in fig. 1A); P, penis (St, the basal segment or "stalk"; DS, the distal segment, with al = anterior lobe, c = claw, ir = internal rods, k = keel, and s = sheath); PC, posterior clasper.

Fig. 2. *Idoneamima sabroskyi* new species, paratype, right lateral view of genitalia. 2A, penis, posteroventral view of distal segment; 2B, forceps, posterior view.

Fig. 3. *Idoneamima acadiana* (Reinhard), from sketches of holotype made by C. W. Sabrosky, forceps, posterior view. 3A, penis, lateral view; 3B, penis, posterior view.

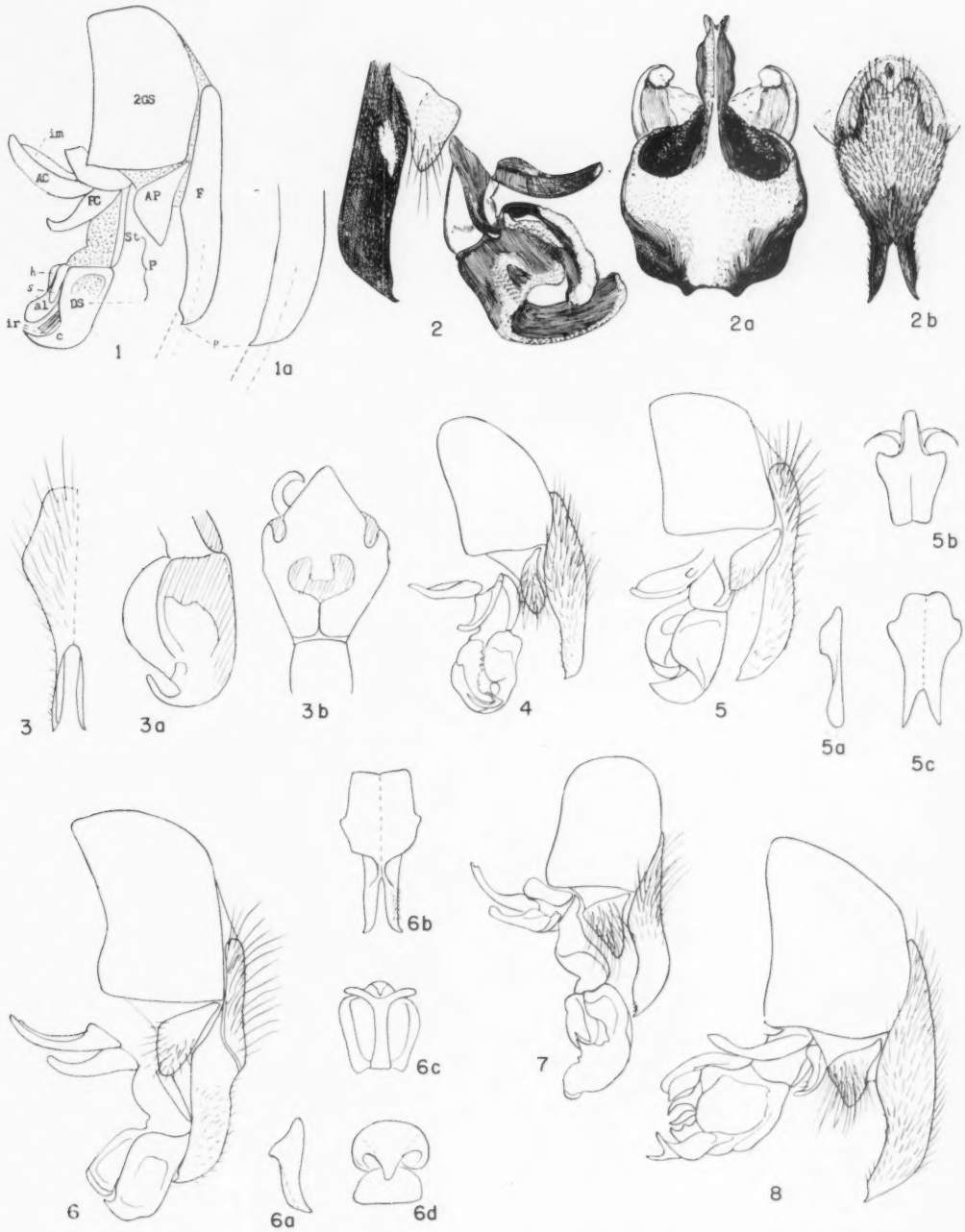
Fig. 4. *Idoneamima acrophila* new species, holotype.

Fig. 5. *Idoneamima bicolor* new species, holotype. 5A, anterior clasper, ventral view; 5B, penis, posterior view of distal segment; 5C, forceps, posterior view.

Fig. 6. *Idonoeamima carinata* new species, holotype. 6A, anterior clasper, ventral view; 6B, forceps, posterior view; 6C, distal segment of penis, anterior view; 6D, same, ventral view.

Fig. 7. *Idoneamima epitheca* (Reinhard), homotype.

Fig. 8. *Idoneamima fattigi* new species, holotype.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Specimens examined: One male homotype (ident. H. J. Reinhard), Rabun Bald, Rabun County, Georgia, August 12, 1952, H. R. Dodge. This specimen is the one illustrated, and is deposited in the U. S. National Museum; one male, same locality, August 2, 1952, C. Dunaphant.

Idoneamima fattigi new species
(FIG. 8)

Male: Front at narrowest 0.160 to 0.187 of head width (average 0.168 of five). Body more pollinose than usual for the genus. Metacephalon pale-haired. Genital segments red, the first pollinose, with a marginal row of eight to ten strong bristles; second segment shining. Forceps black, fine-haired, contiguous and straight on basal 0.7 of their length, thence curved and tapered to the point, which is apical in position. Accessory plate flat, reddish, subtriangular. Claspers dark brown, the anterior pair larger, without internal margin and only slightly swollen externally at base, their apices convergent. Penis with stalk sclerotized and shallowly grooved on posterior margin; distal segment large, globular, the terminal claw suppressed between two large, flattened, lateral processes, each of which has three or four sharp points apically. Anterior process sclerotized, rather large, in ventral view V-shaped. Between the anterior process and the claw, a pair of black, curved, tapered rods.

Female: Unknown.

Holotype male, Blood Mountain, Lumpkin and Union Counties, Georgia, July 13, 1952, W. D. Sudia. Type No. 62787, U. S. National Museum.

Paratypes: Four males, same data as holotype; 1 male, same locality, August 1, 1952, H. R. Dodge; 48 males, Rabun Bald, Rabun County, Georgia, June 20 to September 24, 1952, various collectors; 2 males, same locality, June 13, 1954, H. R. Dodge; 17 males, Mt. Enotah, Towns and Union Counties, Georgia, July 13 to September 11, 1952, Dodge, Sudia and Seago; 2 males, Tray Mountain, Towns and White Counties, Georgia, May 13, 1953, H. R. Dodge; 13 males collected by the late P. W. Fattig, 1950 to 1952, from the following localities: Levelland Mountain, Blue Mountain, Tray Mountain, Black Mountain, and Fort Mountain.

Variation: Most of the series have the apex of the fourth tergite red and the first genital tergite wholly red, or vaguely darker on the basal half. Ten have the fourth tergite wholly black; one has the first genital segment black except on hind margin. Four have an extra bristle among the posterior dorsocentral rows; one has four sternopleurals on one side; five have three median marginals on tergite 3.

Idoneamima fortisa (Reinhard), new combination
Sarcophaga fortisa Reinhard, 1947, J. Kans. Ent. Soc. 20: 110, FIG. 15.

Length 12 to 12.5 mm.

Male: Front at narrowest 0.182 of head width. Metacephalon pale-haired. Genital segments subequal, pollinose, the first dark, with a marginal row of very weak bristles; the second red. Genitalia much like *helicivora*.

Holotype male, Amherst, Ohio, July 14, 1926, in Reinhard collection.

Material examined: One male, Westmoreland County, Pennsylvania, July, Carnegie Museum account 321. Compared with type by Professor Reinhard.

This species is very close to *helicivora*, and since the author has not studied the holotype no attempt to differentiate the genitalia of the two species has been made. *Fortisa* has the hind tibia unusually densely villous for this genus.

Idoneamima helicivora new species
(FIG. 9)

Length 7 to 14 mm.

Male: Front at narrowest 0.160 to 0.198 of head width (average 0.175 of five). Metacephalon pale-haired except for four or five black hairs just behind the suture. Genital segments pollinose, the first black, with a marginal row of several very weakly developed bristles; second segment red. Forceps dark brown on basal half, black apically, separated on apical third of length, in profile slightly curved and tapered apically; the point may be interpreted as apical in some specimens, internal in others in the series. Accessory plate flattened, red, subtriangular, the apical and anterior angles rounded. Claspers dark brown, the anterior pair longer, without internal margin, in ventral view broadened externally at base and with apices convergent. Penis with hind margin of stalk convex in profile, bearing a shallow longitudinal groove. Distal segment of penis rather small, with a stout, curved apical claw; anterior process moderate in size, emarginate apically, the lobes thick and curled as seen in ventral view, and overlapped in great part by a whitish, membranous sheath, the margin of which is not feathered. Between the anterior process and the claw may be seen two slender rods and two compressed, triangular points.

Female: (Kennesaw Mountain, Georgia, in copulation, to be deposited in U. S. National

EXPLANATION OF PLATE II

FIG. 9. *Idoneamima helicivora* new species, paratype.
FIG. 10. *Idoneamima hesterna* (Reinhard).
FIG. 11. *Idoneamima idonea* (Aldrich), topotype.
FIG. 12. *Idoneamima louisianensis* new species, holotype. 12A, apex of forceps, posterior view.
FIG. 13. *Idoneamima mimoris* (Reinhard).
FIG. 14. *Idoneamima montanensis* (Hallock), holotype, sketch of genitalia. 14A distal segment of penis, greatly enlarged, posterolateral view, the shading indicates membranous surface, the two areas designated "x" admitting light; 14B, forceps, posterior view.
FIG. 15. *Idoneamima monticola* new species, holotype.
FIG. 16. *Idoneamima morosa* (Aldrich), homotype.

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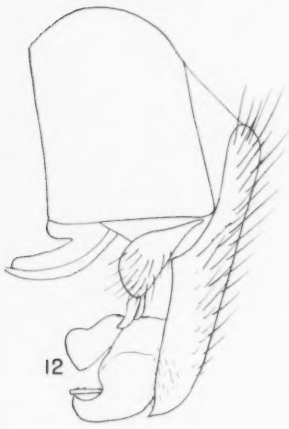

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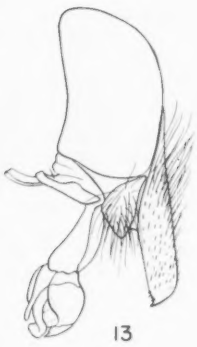
12a



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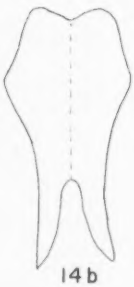
14a



14b

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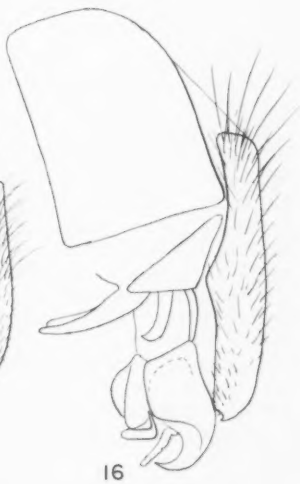

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Museum); first genital segment pollinose, black, reddish on hind margin, completely divided mid-dorsally; venter of abdomen strongly pollinose, only slightly variegated.

Holotype male, Washtenaw County, Michigan, December 30, 1952, reared from snail, *Ventridens ligera* (Say), emerged February 3, 1953, C. O. Berg. Type No. 62788, U. S. National Museum.

Paratypes: Twenty males, Rabun Bald, Rabun County, Georgia, July 6 to September 5, 1952, Dodge and Seago; 13 males, same locality, June 13, 1954, H. R. Dodge; 4 males, Stone Mountain, DeKalb County, Georgia, May 23 to June 22, 1952, Dodge and Seago; 5 males, same locality, April 22 to 28, 1953, H. R. Dodge; 1 male, same locality, May 4, 1939, P. W. Fattig; 5 males, Mt. Enotah, Towns and Union Counties, Georgia, July 19 to August 1, 1952, Dodge and Seago; 3 males, 1 female, Kennesaw Mountain, Cobb County, Georgia, April 17, 1953, J. M. Seago; 1 male, Cheat River, West Virginia, H. H. Smith; 1 male, Montgomery County, Kansas, 1916, R. H. Beamer.

Variation: The first genital segment is reddish in two specimens and the forceps are entirely black in two specimens. In chaetotaxy, two lack a left sternopleural; in one it is the anterior, in the other the posterior bristle. One has only one median marginal on the third tergite. One has five posterior dorsocentrals on each side, with one of the supernumery bristles quite strong.

Biology: The holotype was reared from a snail, *Ventridens ligera* (Say), the adult fly emerging in the laboratory during the winter. Pupation took place within the shell of the snail.

Idoneamima hesterna (Reinhard), new combination

(Fig. 10)

Sarcophaga hesterna Reinhard, 1947, J. Kansas Ent. Soc. 20: 108–109, Fig. 13.

Length 6.5 to 9.5 mm.

Male: Front at narrowest 0.153 to 0.170 of head width (average 0.159 of five). Hind margin of fourth tergite red. Genital segments red, the first pollinose, sometimes dark, with a marginal row of six to eight very weak bristles; second segment shining. Forceps dark brown on basal half, slightly separated on apical third, in profile slightly curved, hardly tapering, the point nearly internal in position. Accessory plate red, flat, nearly parallel-sided at middle of length, tapered to a point at both ends. Claspers dark brown, equal in size, the anterior pair not margined internally, not convergent apically, with a prominent lateral swelling at base. Penis with stalk not grooved posteriorly; distal segment small, with a blunt apical claw followed by two slender rods. Anterior process small, thin and pointed in lateral view, rather rectangular in anterior view, without a sheath.

Female: Not definitely known.

Holotype male, Westport, New York, July 12, 1922, in Reinhard collection.

Material examined: Five males, Rabun Bald, Rabun County, Georgia, July 4 to August 2, 1952, H. R. Dodge (one a homotype, identified by Professor Reinhard); 1 male, Mt. Enotah, Towns and Union Counties, Georgia, August 20, 1952, J. M. Seago; 1 male, Pella, Iowa, J. U. McGuire; 1 male, Laurel Lake, near Jacksonville, Vermont, June 1–15, 1952, H. D. Pratt; 1 male, Mt. Equinox, Vermont, June 5–10; 1 male, 1 female, London, Ontario, June 2, 1953, B. Hartley (from fly traps).

Variation: The Pella, Iowa specimen has the fourth tergite and genital segments entirely yellow, but the genitalia appear to be identical with the series from Georgia. Another Iowa specimen has the forceps setuled along the middle of their length. A careful comparison of these specimens with topotypical material is desired.

The small series from Georgia varies from the fourth tergite broadly red and genital segments both red, to the fourth tergite vaguely red apically and the first genital segment wholly black.

The genitalia of the Vermont specimen are stored in glycerine and the details of the penis are so changed, probably from treatment with KOH, that it was at first thought to be a different species. The anterior process of the penis stands more freely from the distal segment and in its base a translucent "window" appears on its sides. The median rods are free from the penis claw and project much further than they would when in repose.

Idoneamima idonea (Aldrich), new combination

(Fig. 11)

Sarcophaga idonea Aldrich, 1916, Sarcophaga and Allies, p. 90, fig. 34.

Length 10 mm.

Male: Front at narrowest 0.162 to 0.183 (average 0.170 of three) of head width. Genital segments red, shining, the first with a marginal row of eight to ten bristles. Forceps reddish, becoming brown on apical two-fifths, separated on apical quarter of length, with point internal. Accessory plate flat, narrowly triangular. Claspers brown, equal in length, moderately curved, the anterior pair with a slight internal margin. Distal segment of penis with apical claw strongly incurved, its apex concealed by the anterior process; basal portion strongly incurved on the sides; anterior process Y-shaped in anterior view, the arms of the Y not strongly diverging externally, fused internally. In lateral view the anterior process nearly semicircular, with a whitish plume at its base.

Female: Unknown.

Material examined: *Holotype* male, New Bed-

ford, Massachusetts, Type No. 20501, U. S. National Museum; 1 male, same locality (the specimen illustrated; not the paratype mentioned by Aldrich); 1 male, Manchester to Peru, Vermont, July 15, 1935, Blanton and Borders (predet. *idonea* by Hallock); 1 male, Cheat River, West Virginia, H. H. Smith.

Variation: The hind margin of the fourth tergite may be reddish or black and the first genital segment may be entirely black. The anterior clasper of the Cheat Mountain specimen has a stronger internal margin.

Idoneamima louisianensis new species

(FIGS. 12, 12A)

Length 6 mm.

Male: Front at narrowest 0.138 of head width. Hind tibiae villous. Costal spine distinct but closely appressed. Strong and erect median marginal bristles on the second and third abdominal tergites. First genital segment dark brown, pollinose, without a marginal row of bristles. Second genital segment shining, dark brown, sparsely haired, and with a few coarser hairs on the mid-dorsal portion. Forceps shining, finely haired except for coarse spinules laterally on the apical fourth of their length. Forceps dark brown at base, black apically, contiguous for 0.80 of their length; in posterior view the outer margins of the free portion parallel; in profile the forceps straight, parallel for most of their length, the point internal. Accessory plate flat, shining, sparsely haired, semicircular, twice as long as wide, the hind margin straight, the front margin broadly rounded. Claspers dark brown, unequal, the anterior pair longer and broader than the posterior pair. Anterior claspers in ventral view parallel, broad, distinctly widened externally on nearly the basal half; in profile, moderately curved, with an internal margin extending nearly to apex, the apex therefore appearing emarginate. Distal segment of penis ordinary in size and structure. In lateral view the apical claw of the penis moderate in size, curved forward, the apex tapered to a small hook, under which one internal rod is exposed; in posterior view the claw triangular, its sides merging imperceptibly with the breadth of the distal segment. Anterior process of distal segment of penis not distinctly keeled or sheathed, in profile with an outer notch subapically; in anterior view Y-shaped, the arms of the Y divergent, stout, rounded apically.

Holotype male, Beauregard County, Louisiana, August 9, 1928, R. H. Beamer, in the University of Kansas collection. This unique specimen is somewhat teneral, and the frontal width may normally be slightly greater than indicated. The genital segments and abdomen are brownish, apparently due to immaturity.

Idoneamima mimoris

(Reinhard), new combination

(FIG. 13)

Sarcophaga mimoris Reinhard, 1947, J. New York Ent. Soc. 20: 110–111, fig. 16. Steyskal, 1949, Pap. Mich. Acad. Sci., Arts Lttrs. 33: 174–176, fig. 1.
Sarcophaga neali Steyskal, manuscript name.

Length 5.5 to 10 mm.

Male: Front at narrowest 0.150 to 0.187 of head width (average 0.170 of five). Genital segments reddish, the first darker, pollinose, with four weak bristles in the marginal row; second segment shining. Forceps reddish or brownish on most of their length, separated on apical fifth of their length; in profile straight and parallel-sided nearly to apex, the point internal. Accessory plate red, flat, semicircular, the posterior margin straight. Claspers brown, equal, nearly straight, the anterior pair not internally margined, in ventral view slender, parallel. Penis with long basal stalk, the distal segment moderate in size, with apical claw moderately compressed, rather short and blunt; anterior process in anterior view Y-shaped, with a sharp-pointed process representing the sheath on either side from its base; in lateral view the arms of the Y thickened and recurved apically.

Female: Not definitely known or adequately described.

Holotype male and 5 male, 1 female paratypes: Amherst, Ohio, July 16, 1930, H. J. Reinhard, in Reinhard collection.

Material examined: One paratype in University of Kansas collection; 2 males, Lafayette, Indiana, May 19, 1917 (Parker Collection); 2 males, Ann Arbor, Michigan, June 3 and July 16, 1927, N. K. Bigelow; 1 male, Washtenaw County, Michigan, April 16, 1953, reared from snail, *Ventridens ligera* (Say), C. O. Berg; 1 male, Grosse Ile, Wayne County, Michigan, May 20, 1949, G. Steyskal; 2 males, Detroit, Michigan, G. Steyskal (Holotype and paratype of *neali*, in U. S. National Museum); 1 male, Blue Ridge Summit, Pennsylvania, August 8, 1920, Aldrich Collection; 1 male, Allegheny County, Pennsylvania; 1 male, Charleston, West Virginia, August 25, 1949, CDC fly trap; 1 male, Baltimore, Maryland, July, 1951, F. M. Snyder; 2 males, Zoological Park, Washington, D. C., May 7, 1938, D. G. Hall.

Variation: In a series of seven, three had the hind margin of the fourth tergite red; the first genital segment varied from black to only slightly darker than the second.

Biology: One male from Washtenaw County, Michigan, was reared from a snail, *Ventridens ligera* (Say) [*Gastrodonta* sp.], by C. O. Berg. Pupation occurred within the shell of the host, as is generally the case in species which are obligatory parasites of snails.

Steyskal suppressed the name *neali* in his publication, but the name occurs in Biological

Abstracts and on the two types in the U. S. National Museum.

Idoneamima montanensis
(Hallock), new combination
(FIGS. 14, 14A, 14B)

Sarcophaga montanensis Hallock, 1938, Proc. Ent. Soc. Washington 40: 98, fig.; 1942, J. New York Ent. Soc. 50: 222, fig. 164.

Length 13 mm.

Male: Front at narrowest 0.177 of head width. Genital segments black, shining, the first with a marginal row of nine bristles. Forceps separated on nearly the apical third, in profile straight, tapered apically to the point, which is internal. Accessory plate reddish, subtriangular, the posterior margin longest. Claspers subequal in length, moderately curved, the anterior pair evidently with a slight internal margin. Distal segment of penis large, with the apical claw, the anterior process and the sides of the basal piece all incurved, overlapping apically in lateral view, but one can see through the segment on either side of the side piece. Between the side piece and the claw the segment deeply U-shaped, excised; in the base of the excision a small, peglike spine, visible in posterolateral view. The anterior process not visible in anterior view, but probably strongly keeled for most of its length, with a groove or V-shaped notch apically. At its sides basally a whitish plume, as in *idonea*.

Female: Unknown.

Holotype male, White Face Mountain, Adirondacks, New York, 3800 ft. altitude, J. M. Aldrich, Type No. 52085, U. S. National Museum. This is the only specimen known, and was examined by the author. The details of the genitalia suggest a close relationship with *idonea*, despite the black genital segments and four posterior dorsocentral bristles.

Idoneamima monticola new species
(FIG. 15)

Length 7 to 12 mm.

Male: Front at narrowest 0.137 to 0.150 of head width (average 0.145 of five). Genital segments black, pollinose, the first without a marginal row of bristles. Forceps black, separated on apical third, in profile slightly curved beyond middle, scarcely tapered to the blunt apex, the point apical. Accessory plate brownish, subtriangular, the posterior margin straight and anterior margin nearly uniformly convex. Claspers dark brown, subequal, the anterior pair nearly straight, with internal margin; in ventral view without a lateral swelling at base and with apices only slightly convergent. Penis with stalk shallowly grooved posteriorly; distal segment moderately large, the claw acuminate and curved at nearly a right angle to the length of the segment. Anterior process emarginate apically, with a prominent keel on its basal half; in profile the anterior margin very convex on basal two-thirds, thence notched. On either side of the anterior process a closely appressed, whitish membranous sheath. Between the anterior process and the claw two exposed, curved rods.

Female: Two specimens from Mt. Enotah are probably this species.

Holotype male, Mt. Enotah, Towns and Union Counties, Georgia, August 20, 1952, J. M. Seago. Type No. 62789, U. S. National Museum.

Paratypes: Thirty-seven males, same data; 41 males, same locality, July 19 to September 23, 1952, Dodge, Seago and Sudia; 9 males, same locality, May 13, 1953, J. M. Seago; 7 males, Tray Mountain, Towns and White Counties, Georgia, May 13, 1953; 19 males, Rabun Bald, Rabun County, Georgia, July 12 to August 12, 1952, Dodge, Good and Seago; 1 male, Black Mountain, Georgia, August 21, 1951, P. W. Fattig; 1 male, Enotah Bald (Mt. Enotah), Georgia, August 11, 1951, P. W. Fattig; 7 males, Wayah Bald, Macon County, North Carolina, July 27, 1952, Dodge and Good; 1 male, Mt. Graybeard, North Carolina, May 23, N. Banks Collection.

Variation: There is no variation in coloration of the body; the metacephalon has two to many black hairs anteriorly. In chaetotaxy, two have an extra pair of posterior dorsocentrals; two have a small, wide-set pair of median marginals on the second tergite; one has only one median marginal on the third tergite and three have three median marginals on the third tergite.

Professor Reinhard first identified specimens of this series as *morosa*, and later as *elanis*, with the reservation that certain specimens were not quite identical with the type of *elanis*. The author believes that the entire Georgia series is conspecific, and that the latter synonymy may be correct.

Idoneamima morosa (Aldrich), new combination
(FIG. 16)

Sarcophaga morosa Aldrich, 1925, Proc. U. S. Nat. Mus. 66(18) no. 2555: 26–27, fig. d. Greene, 1925, Proc. U. S. Nat. Mus., 66(29) no. 2566: 18, fig. 30.

Length 10.5 to 13 mm.

Male: Front at narrowest 0.178 to 0.189 of head width (average 0.185 of three). Genital segments black, pollinose, the first without marginal row of bristles. Forceps brownish on basal half; separated on apical fourth, in profile slightly bent beyond middle, tapered to a blunt apex, with point apical in position. Accessory plate brown, shining, its surface concave in longitudinal section, its shape distinctive, triangular, with the anterior margin longest and the apical margin shortest; it is thus directed forward instead of ventrally. Claspers brown, unequal, the anterior pair longer, with slight internal margin; in ventral view the anterior

pair are widest at base but without an abrupt basal swelling, the apices slightly convergent. Penis with stalk strongly grooved posteriorly; distal segment moderate in size, with a strongly bent and sharply acuminate claw and a pair of median rods visible. Anterior process strongly keeled on basal two-thirds, the apex hardly emarginate in anterior view but with two outwardly directed apical lobes and, from base on each side, a whitish sheath.

Female (of mated pair, in Carnegie Museum): Genital segments black; venter of abdomen strongly pollinose.

Material examined: Holotype male, near Ottawa, Ontario, July 11, 1918, F. Johansen, Type No. 27098, U. S. National Museum; 1 male, St. Thomas, Ontario, July 18, 1926, James Collection; 1 male, Point Pelee, Ontario, July 24, 1925, G. S. Walley; 2 males, homotypes, one, Columbus, Ohio, May 14, 1926, H. W. Allen, the other without locality label, Hall Collection; 1 male, Manchester, Washtenaw County, Michigan, July 21, 1927, F. M. Gaige; 1 male, New York; 1 male and 1 female on same pin, Bluff Island, Clayton County, New York, August 18, 1917, H. Kahl.

Variation: The two males from the Hall Collection agree with the type except that the internal margin of the anterior clasper is not so strong. All three have the accessory plate and bases of forceps brownish.

The holotype has the puparium pinned with the insect, but no data on the circumstances of capture. The puparium was figured by Greene (1925).

Idoneamima ontariensis (Hall), new combination

(Figs. 17, 17A)

Sarcophaga ontariensis Hall, 1932, Canad. Ent. 64: 102–103, fig. 000.

Sarcophaga sima Hallock, 1942, J. New York Ent. Soc. 50: 227, fig. 182.

Male: Front at narrowest 0.123 to 0.149 of head width (average 0.132 of four). Fourth tergite red on hind margin. Genital segments red, the first pollinose, with a marginal row of eight to ten bristles; the second shining. Forceps red on basal half, separated on apical fourth, in profile slightly curved, with point nearly internal. Accessory plate red, shining, flat, subtriangular, the hind margin straight on basal two-thirds. Claspers brown, unequal, the anterior pair longer, without internal margin, in ventral view broadest on apical portion, convergent apically. Penis with stalk grooved posteriorly; distal segment rather large, with apical claw long, attenuated, strongly curved forward. Anterior process in anterior view stout, Y-shaped, the base moderately keeled, not with an enveloping sheath, the arms flattened, free from the distal segment, with tips curved inward. Because of the strong curvature of the arms of the Y, the anterior process appears only moderately notched in anterior view. Median rods of the distal segment enveloped by the apical claw.

Holotype male, Orillia, Ontario, June 16–21, 1927, C. H. Curran, in Canadian National Collection.

Specimens examined: One male, paratype, same data as holotype, Type No. 43812, U. S. National Museum; 3 males (predetermined "*sima*" by Hall and Hallock, in Cornell University Collection) Trenton Falls, New York, June 5–8, 1921, Leonard and Forbes; Ithaca, New York, July 8, 1924; Duck Lake, Conquest, New York, August 5, 1921, R. C. Shannon; 1 male, Blood Mountain, Georgia, May 25, 1940, P. W. Fattig (previously ident. "new species" by Hall); 6 males, Kirkwood, Missouri, September 6–11, 1952, Wm. L. Downes.

Three of the four localities listed by Hallock (1942) for "*sima*" are listed in the above paragraph. A fourth male "*sima*" from Cornell University proved to be *sabroskyi*.

Variation: The second tergite lacks median marginal bristles on the paratype and other specimens which were checked for this character; these bristles are present, according to the original description.

Idoneamima parallela (Aldrich), new combination

Sarcophaga parallela Aldrich, 1916, *Sarcophaga* and Allies, pp. 123–125, fig. 50. Bequaert, 1925, J. Parasit. 11: 204. Hallock, 1942, J. New York Ent. Soc. 50: 223, fig. 166–168.

Length 8 to 10.5 mm.

Male: Front at narrowest 0.143 to 0.168 of head width (average 0.156 of five). Hind tibia non-villous. Hind margin of fourth tergite red. Genital segments red, the first pollinose, with an interrupted marginal row of six to eight weak bristles; the second shining. Forceps red basally, black apically, in posterior view strongly constricted at the base of the free portion, separated on the apical fourth of length, the apices strongly divergent or nearly contiguous. Beyond the constriction the forceps are somewhat margined dorsolaterally, and concave below the margin. In lateral view the forceps are bent at the constriction, the point apical in position. Accessory plate red, flat, subtriangular, the hind margin longest and straight. Claspers brown, slightly bent, subequal in length, the anterior pair slightly longer, with thin internal margin. In ventral view the anterior claspers parallel, widest and parallel-sided on basal third, constricted at middle, widening again apically. Penis with basal stalk grooved posteriorly; distal segment with a posterior keel at base, the apical claw compressed and strongly bent, acuminate. Side pieces of the distal segment and the anterior process largely whitish, membranous in appearance, and closely appressed to each other; no median rods visible. Anterior process with keel at base, the apex emarginate, membranous.

Female: Unknown with certainty.

Type series: Holotype, Trenton, New Jersey, Type No. 20512, U. S. National Museum; paratypes: 1 male, identical label; 2 males, Philadelphia, Pennsylvania, April 19 and 21, 1891; 1 male, same locality; 1 male, Roxboro, Pennsylvania; 1 male, Columbus, Ohio.

Material examined: Holotype and 2 paratypes in U. S. National Museum; 2 paratypes, Philadelphia, in Chicago Natural History Museum; 1 male, Sag Harbor, Long Island, New York, May 7, 1947, Roy Latham; 1 male, Baltimore, Maryland, July, 1950, F. M. Snyder; 1 male, Chevy Chase Lake, Maryland, May 13, G. E. Quinter; 2 males, Washington, D. C.; 2 males, Falls Church, Virginia, N. Banks; 2 males, DeKalb County, Georgia, H. R. Dodge and D. A. Dodge; 1 male, Atlanta, Georgia, July 7, 1949, P. W. Fattig; 2 males, Florence, Alabama, August 9 and 14, 1946, fly traps; 10 males, Clarksville, Tennessee, 1936 (in part labeled April 18 and May 12), E. W. Howe; 3 males, 2 females, Nashville, Tennessee, August 24 to 27, 1947, H. R. Dodge, fly traps; 2 males, Charleston, West Virginia, April 29, 1949 and August 24, 1952, CDC fly traps; 1 male, Cheat Mountains, West Virginia, H. H. Smith; 1 male, Franklin County, Ohio, J. S. Thomas; 1 male, St. Louis, Missouri, June 19, 1952, F. C. Harmston; 1 male, Washington County, Arkansas, April 26, 1927, D. G. Hall.

Mr. Fattig has records of this species from Cartersville, Dahlonega and Cornelia, Georgia.

Hallock (1942) records this species from New York: "Inwood, L. I.: West Hills, April to October."

Variation: Professor Fattig's specimen has a wide-set pair of median marginal bristles on the second tergite. Considerable variation in the divergence of the forceps apices is of no significance, since the fused basal portion is capable of limited movement along the hinge. All specimens have the genital segments and hind margin of fourth tergite red, the metacephalon with less than six black hairs anteriorly.

Biology: Hallock (1942) states that Leonard (1928) records a pupa in a dead snail, *Mesodon thyroidus* (Say) = *Helix thyroides*. Bequaert (1925) elaborated on what is evidently this record: "Mr. Wm. T. Davis communicated to me several specimens of *Sarcophaga parallela* Aldrich (identified by Aldrich), which he bred in October, 1908, from dead *Polygyra thyroides* (Say), collected at Inwood, New York City."

Puparium: The two paratypes in the Chicago Natural History Museum are pinned with their puparia. Two outstanding features of the puparium are (a) in profile the dorsal surface is straight, the ventral strongly convex, and (b) the posterior spiracular chamber is flattened and only slightly depressed, its margin circular, without processes.

This is one of the most widely distributed species known, but it is rare in collections. Though it ranges southward to Atlanta, Georgia, its absence in summit collecting in northern Georgia suggests that the male of this species is not acrophilous.

Idoneamima paulina (Hall), new combination

(FIGS. 18, 18A, 18B, 18C)

Sarcophaga paulina Hall, 1937, Proc. U. S. Nat. Mus. 84 (3011): 212–213.

Length 7 to 9 mm.

Male: Front at narrowest 0.174 to 0.180 of head width (average 0.177 of three). Genital segments black, pollinose, the first without a marginal row of bristles. Genitalia very similar to *monticola* with exception that the anterior clasper is, in profile, very thin and strongly curved, without internal margin. In ventral view the anterior clasper broadest at base, thence tapering gradually to the bluntly rounded apex, with a translucent external margin on the apical half. Claspers subequal in size. Anterior process of penis not strongly keeled basally; apically with two thin, sclerotized lobes which project away from the segment and appear thin in ventrolateral view, semicircular and separated by a U-shaped notch in ventral view. Base of the anterior process broadly covered on each side by a membranous whitish sheath. In anterior view the anterior process shallowly V-notched at apex.

Female: Unknown.

Holotype: "Miami County, Ohio, June 14, 1928, D. G. Hall," Type No. 51687, U. S. National Museum; *paratype* male, Lucas County, Ohio, June 19, 1928. Not examined by author; they are apparently lost, although supposed to be deposited in the U. S. National Museum.

Material examined: Two male homotypes, identified by C. W. Sabrosky, are accepted as authentic. One, Toledo, Ohio, June 15, 1926; one, Baltimore, Maryland, June 11, 1950, F. M. Snyder. A third male, Neel Gap, Georgia, April 27, 1946, P. W. Fattig, is similar and identified as *paulina* by me. It was previously identified as

EXPLANATION OF PLATE III

FIG. 17. *Idoneamima ontariensis* (Hall). 17A, anterior lobe, much enlarged, anterior view.

FIG. 18. *Idoneamima paulina* (Hall). 18A, forceps, posterior view; 18B, anterior clasper, ventral view; 18C, penis, ventral view.

FIG. 19. *Idoneamima pleomenda* (Reinhard).

FIG. 20. *Idoneamima pratti* new species, holotype.

FIG. 21. *Idoneamima rabunensis* new species, holotype.

FIG. 22. *Idoneamima seagoi* new species, holotype.

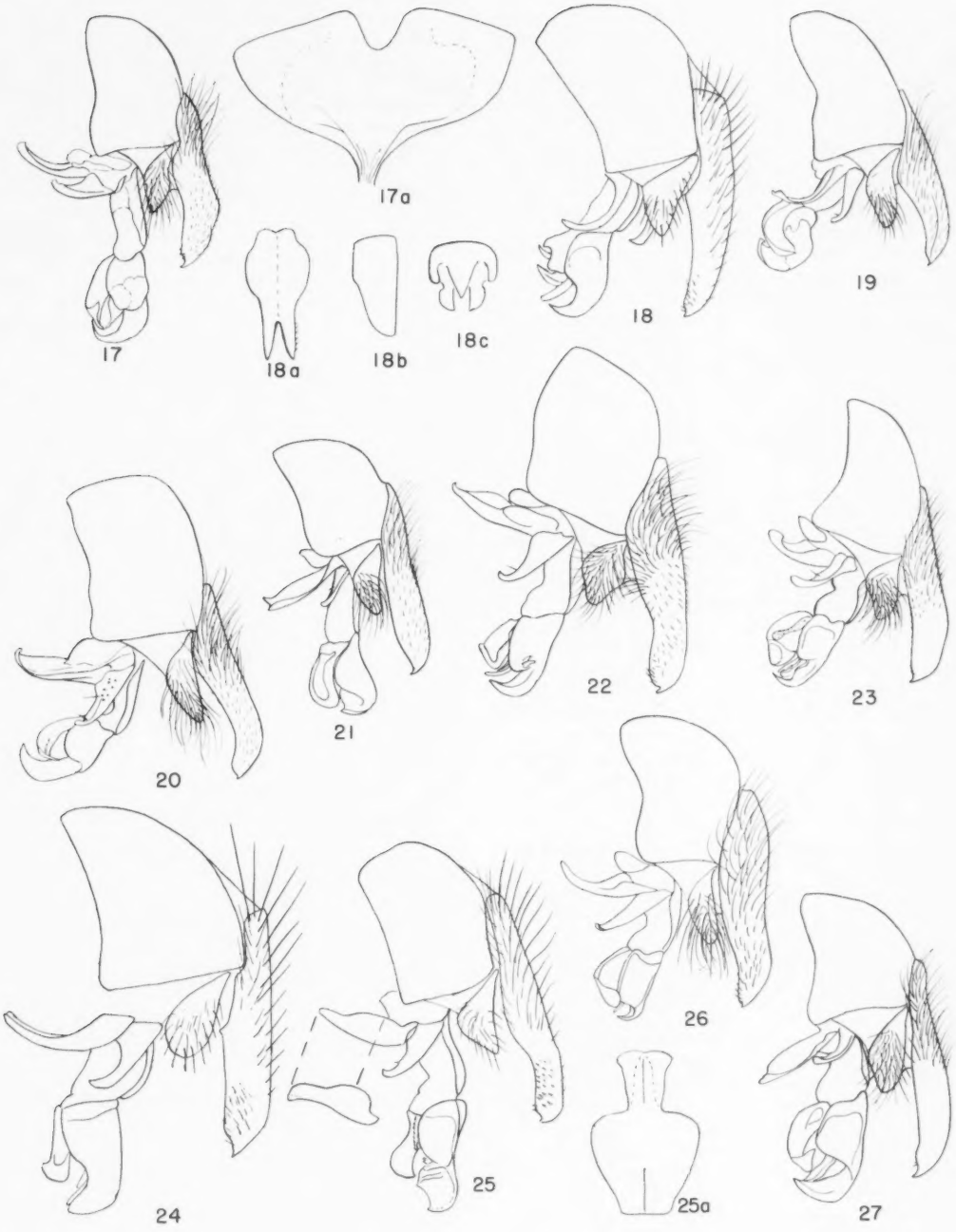
FIG. 23. *Idoneamima sima* (Aldrich).

FIG. 24. *Idoneamima smithi* new species, holotype.

FIG. 25. *Idoneamima snyderi* new species, holotype. 25A, penis, distal segment, posterior view.

FIG. 26. *Idoneamima sudiai* new species, holotype.

FIG. 27. *Idoneamima sutilis* (Reinhard).


17
17a
18a
18b
18c
18
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25a
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27

"new species near *morosa*" and "near *elanis*" by Sabrosky and "*elanis*" by Reinhard. However, the anterior clasper differs greatly from that in *elanis*, and this has been verified by Professor Reinhard.

Variation: The specimen illustrated is the one from Baltimore. It has the median rods free of the penis claw and the sheath of the anterior process pubescent and not closely appressed to the process. The other two specimens have the median rods partly concealed and the sheath more retracted, without apparent pubescence. The tip of the claw is much closer to the anterior process in the Georgia specimen than in the Ohio specimen. The genitalia of the latter two are not in good condition. All three have identical anterior claspers and appear to be identical in other details of the anterior process, forceps and accessory plate, and it is believed all are conspecific.

Idoneamima pleomenda (Reinhard), new combination

(FIG. 19)

Sarcophaga mendax Reinhard (not Walker), 1947, J. Kans. Ent. Soc. 20: 107–108, fig. 11.
Sarcophaga pleomenda Reinhard, 1953, Proc. Ent. Soc. Washington 55: 243.

Length 5 to 8.5 mm.

Male: Front at narrowest 0.164 to 0.190 of head width (average 0.173 of five). Genital segments black, pollinose, the first without a marginal row of bristles. Forceps dark brown, becoming black apically; separated on the apical quarter; in lateral view rather strongly curved apically, the point apical in position. Accessory plate dark brown, flattened, semicircular in shape, the posterior margin straight. Claspers dark brown, the anterior pair somewhat longer, without an internal margin, strongly bent at about the middle of their length, with apex emarginate. In ventral view the anterior claspers rather broad and slightly convergent basally, tapered to the parallel apices. Distal segment of penis moderately small and compact, rather S-shaped, the apical claw strongly curved forward and inward, the anterior process closely adhering to the body of the segment, terminating on each side in an acute, compressed process which is raised some distance from the surface of the segment. Much of the surface of the anterior process whitish, membranous. Median rods of distal segment not apparent.

Female: Unknown.

Holotype: Great Smoky Mountain National Park, Tennessee, July 15, 1926, in the Reinhard Collection.

Material examined: 21 males, Rabun Bald, Rabun County, Georgia, May 20, 1952 to September 24, 1952, Seago, Sudia, Dodge and Fattig; 1 male, same locality, May 13, 1953, H. R. Dodge; 2 males, Graves Mountain, Lincoln County, Georgia, April 3, 1953, J. M. Seago; 2 males, Tray Mountain, Towns and White Counties, Georgia, May 13, 1953, H. R. Dodge; 5 males (2 are homotypes, ident. Reinhard), Blood Mountain, Union and Lumpkin Counties, Georgia, August 1, 1952, H. R. Dodge; 3 males, Kennesaw Mountain, Cobb County, Georgia, April 3 and 24, 1953, J. M. Seago.

Variation: None has been observed in coloration; in chaetotaxy, one has a middle posterior dorsocentral bristle reduced, smaller than the first.

Idoneamima pratti, new species

(FIG. 20)

Length 10 to 11.5 mm.

Male: Front at narrowest 0.150 to 0.154 of head width. Genital segments pollinose, the first dark basally but reddish apically, especially on the sides, without marginal row of bristles; second segment red. Forceps reddish basally, separated on apical fifth; in profile moderately curved apically, the point apical. Accessory plate flat, red, more than twice as long as wide, semicircular in shape, the hind margin straight. Claspers subequal in length, the anterior pair with an internal margin, in ventral view with a moderate but abrupt basal expansion of the outer margin, the apices parallel. Penis with stalk not grooved posteriorly; distal segment with a large, curved, strongly compressed claw, which is longer than the body of the segment. Anterior process longer and broader than the body of the distal segment, terminating in a pair of slender horns at the lateral extremities. Between the horns the apical margin truncate, but appearing to be deeply notched by a U-shaped excision in the middle; however, this "excision" is transparent chitin. Externally on either side the anterior process enclosed by a sheath which becomes translucent, whitish, laterally; the apices lying just below the horns.

Female: Unknown.

Holotype: Rabun Bald, Rabun County, Georgia, August 2, 1952, H. R. Dodge; Type No. 62790, U. S. National Museum.

Paratypes: One male, Charleston, West Virginia, July 12, 1951, CDC fly trap, in CDC collection; 1 male, Kennesaw Mountain, Cobb County, Georgia, May 7, 1953, J. M. Seago.

Idoneamima rabunensis new species

(FIG. 21)

Length 6 to 8.5 mm.

Male: Front at narrowest 0.130 to 0.151 of head width (average 0.145 of five). Genital segments black, or the second red; the first thinly pollinose, with an interrupted marginal row of eight weak bristles; the second entirely shining. Forceps black, separated on apical fourth; in profile straight and parallel-sided nearly to the

apex, the point internal in position. Accessory plate dark brown, flattened, elongate oval, the posterior margin nearly straight. Claspers dark brown, unequal, the anterior pair much longer, in ventral view parallel, slender basally. In profile the anterior clasper straight and remarkably thickened to the apex, which is emarginate. Penis with basal segment not grooved posteriorly; distal segment moderate in size, unusually prolonged behind to join the basal segment; claw brown, compressed, unusually broad, short, and curved forward at more than a right angle. Anterior process black and shining, about as large as the body of the distal segment, with a median keel best developed on the distal half, the apex not notched, the sides without a membranous sheath.

Female: Unknown.

Holotype: Rabun Bald, Rabun County, Georgia, July 26, 1952, H. R. Dodge. Type No. 62791, U. S. National Museum.

Paratypes: Fourteen males, same data as holotype; 39 males, same locality, July 12 to September 24, 1952, H. R. Dodge; 3 males, same locality, May 12, 1953, H. R. Dodge; 26 males, same locality, June 13, 1954, H. R. Dodge; 1 male, same locality, September 17, 1952, P. W. Fattig.

Variation: of 56 specimens, 18 have black genital segments; in the others the second segment is reddish. Two have a pair of median marginal bristles on the second tergite; one has three median marginals on the third.

This species has been taken only at the summit of Rabun Bald, and all but two specimens were taken on the upper part of the forestry observation tower.

Idoneamima seagoi new species
(FIG. 22)

Length 8.5 to 14 mm.

Male: Front at narrowest 0.144 to 0.166 of head width (average 0.154 of five). Genital segments variable in coloration, the first pollinose, with two pairs of very weak, widely separated marginal bristles; second segment shining. Forceps black, separated on apical third, in profile slightly angled at about middle, the apices blunt, with point apical in position. Accessory plate red, flat, suboval, the posterior margin straight for most of its length, then rounded to the apex, the anterior margin rounded. Claspers brown, subequal; the anterior pair stout, slightly bent, with a broad internal margin, the outer margin basally curved inwards and appearing quite thick. In ventral view the anterior claspers only moderately swollen externally at base, and with apices convergent. Penis with stalk shallowly grooved posteriorly; distal segment moderate in size, with claw acuminate, not compressed, strongly curved forwards, enclosing several rods. Anterior process projecting beyond body of segment, in profile crescent-shaped, without a median keel; in anterior view Y-shaped, the notch of the Y very shallow. On either side at its base a thin, membranous sheath; the apex of the process, in ventral view, also apparently covered by a thin, membranous sheath.

Female: Unknown.

Holotype: Mt. Enotah, Towns and Union Counties, Georgia, August 1, 1952, J. M. Seago. Type No. 62793, U. S. National Museum.

Paratypes: Seventeen males, same data as holotype; 24 males, same locality, July 13 to August 20, 1952, Dodge, Seago and Sudia; 150 males, Rabun Bald, Rabun County, Georgia, June 20 to September 24, 1952, Seago, Sudia, Dodge and Good; 22 males, same locality, June 13, 1954, H. R. Dodge; 1 male, same locality, July 1, 1939, P. W. Fattig; 14 males, Tray Mountain, Towns and White Counties, Georgia, July 24, 1952 and June 11, 1953, P. W. Fattig; 23 males, Wayah Bald, Macon County, North Carolina, July 27, 1952, Dodge and Good; 1 male, Smoky Mountain National Park, Tennessee-North Carolina, Whittaker.

Variation: Usually the first genital segment is black and the second reddish brown, but 5 have both segments entirely black, 13 have both reddish, brown in dorsal view (the first is still darker than the second in lateral view), and others are black, with the apex of the first segment paler. Variation in chaetotaxy are slight; 210 specimens were examined and no variation was found in the posterior dorsocentral bristles, sternopleural or notopleural bristles; also, none had setules on the propleurae. Two had only one median marginal on the second tergite; one had only one median marginal on the third and two had three median marginals on the third tergite.

Idoneamima sima (Aldrich), new combination
(FIG. 23)

Sarcophaga sima Aldrich, 1916, *Sarcophaga* and Allies, pp. 91–92.

Other records of this species are based upon misidentifications. Aldrich's figure for this species (fig. 35) is from the paratype male in the Hough collection, now at the Chicago Natural History Museum. The writer has examined this specimen and found it to be *sutilis* Reinhard, and from Tifton, Georgia, not Opelousas, Louisiana, as stated. Hall's (1929) record of *sima* from Montgomery County, Kansas cannot be confirmed, since the specimen in the University of Kansas Museum which bears his label has lost its genitalia. Other specimens with identical locality labels are identified as *helicivora* and *beameri*. For Hallock's (1942) records of *S. sima* see *ontariensis* and *sabroskyi*, and for Swingle's (1930) record see *sutilis*.

Length 9.5 to 12.5 mm.

Male: Front at narrowest 0.133 to 0.162 of head width (average 0.147 of five). Genital segments reddish or the first slightly infuscated to black; first segment pollinose, with a marginal row of about eight weak bristles; second segment shining. Forceps black, separated on apical 0.3 of their length, in profile slightly bent and tapered apically to the point, which is internal. Accessory plate red, flat, subtriangular. Claspers brown, equal in length, moderately bent, the anterior pair with internal margin and, in ventral view, broadest at base, narrowest at middle, their apices convergent. Penis with basal stalk only slightly grooved posteriorly; distal segment of moderate size, with claw strongly bent and acuminate, not compressed basally. Anterior process rather semicircular in lateral view, with a median keel which is strongest at the middle of the length of the process; apex of process not emarginate. On either side of the anterior process and appressed to it, a thin, opaque, white membranous sheath. Between the anterior process and the claw two pairs of rods are commonly observed, of which the longer pair is bent.

Female: Front at narrowest (vertex) 0.244 to 0.280 of head width. Venter of abdomen subshining, lightly pollinose. Genital segments red, shining, the first genital tergite divided middorsally. Not described in detail due to lack of knowledge of specific female characters in this genus.

Holotype and allotype: male and female, respectively, on same pin, Plummer's Island, Maryland, June 21, 1908, F. Knab. Type No. 20502, U. S. National Museum.

Material examined: The types, above listed; one mated pair, Kennesaw Mountain, Cobb County, Georgia, June 27, 1952, H. R. Dodge; 30 males, same locality, March 24 to May 20, 1953, various collectors; 52 males, Stone Mountain, DeKalb County, Georgia, May 2 to June 22, 1952 and April 22 to May 2, 1953, various collectors (10 of the preceding were taken by fly trap); 1 male, Fort Mountain, Murray County, Georgia, April 30, 1950, P. W. Fattig; 1 male, Clarksville, Tennessee, 1936, E. W. Howe; 4 males, University of Tennessee Farm, Knoxville, Tennessee, 1951 and 1952, H. B. Reed (taken from dog carcasses); 3 males, Chestuee Creek, near Athens, Tennessee, April 21 and June 28, 1952, W. E. Snow (from fly traps); 3 males, Charleston, West Virginia, August 24 to September 7, 1952, CDC fly traps; 4 males, Kirkwood, Missouri, September 6 and 11, 1952, William L. Downes.

Variation: Two specimens have a weak bristle between the first and second posterior dorsocentral bristles; four have weak median marginals on the second tergite. In coloration, four have the fourth tergite entirely black; the others have the hind margin reddish.

Idoneamima smithi new species
(Fig. 24)

Length 11 mm.

Male: Front at narrowest 0.190 of head width. Median marginal bristles on the intermediate tergites, the first pair weak, Genital segments pollinose, the first black, without marginal bristles; the second red. Forceps reddish on basal half, thence darker, separated on apical 0.26 of length, in lateral view nearly straight, parallel-sided nearly to apex, with point apical in position. Accessory plate flat, red, shaped like half of a valentine heart, the posterior margin straight on basal two-thirds. Claspers brown, moderately bent, unequal, the anterior pair longer, without internal margin, in ventral view only slightly swollen basally, the apices moderately convergent. Penis with basal stalk strongly arched on hind margin in profile, shallowly grooved posteriorly; distal segment with broad, blunt claw. Anterior process of penis Y-shaped in anterior view, the basal section not keeled; the tips of the arms flattened and semicircular in ventral view, connected by a thin margin.

Female: Unknown.

Holotype: Cheat Mountains, West Virginia, Carnegie Museum Acct. 91 (H. H. Smith, collector), J. M. Aldrich collection. Type No. 62794, U. S. National Museum. It bears Aldrich's label "*Sarcophaga tetra*," but differs from that species in details of the anterior clasper and penis.

Idoneamima snyderi new species
(Fig. 25, 25A)

Length 11 mm.

Male: Front at narrowest 0.176 of head width. Abdomen black, the fourth tergite slightly reddish on hind margin dorsally. Genital segments reddish, the first darkened basally, pollinose, with an interrupted marginal row of 11 bristles; the second segment shining. Forceps black, dark brown basally, separated on apical 0.38, the outer sides of the free portion with unusually bristly vestiture; in lateral view slightly bent beyond the middle, the point apical. Accessory plate flat, red, subtriangular. Claspers unequal, the anterior pair slightly longer, in ventral view convergent, their apices approximate, their basal halves each greatly broadened by a depressed lateral expansion. In profile the anterior claspers are nearly straight, thickened basally, without an internal margin. Penis stalk sclerotized and grooved posteriorly; distal segment moderate in size, with basal posterior keel; the apical claw greatly modified by a curved, hood-shaped extension which bears a translucent median septum connecting it to the length of the claw. Anterior process in profile thin basally, not keeled, thence broadened and curved on apical half; in anterior view dark,

sclerotized, scarcely notched apically, with a whitish membrane on each side which appears more like an explanate margin than a sheath. In ventral view, the anterior process broadly U-shaped.

Female: Unknown.

Holotype male, Nezpique Bayou, Acadia Parish, Louisiana, May 29–30, 1937, Fred Snyder, collector. Type in American Museum of Natural History.

This species is unusually distinct from the others by the structure of the anterior claspers and claw and anterior process of the penis.

Idoneamima sudiai new species
(FIG. 26)

Length 9 to 11 mm.

Male: Front at narrowest 0.146 to 0.171 of head width (average 0.161 of six). Metacephalon mostly black haired. Hind tibiae non-villous, but with 2–7 small, suberect posteroventral bristles which may be mistaken for villosity. Hind margin of fourth tergite red. Fifth sternite reddish, V-cleft, with three rows of small black bristles on the margins of the cleft. First genital segment black, pollinose, with six very weak bristles in an interrupted marginal row; second segment red, shining. Forceps black, shining, separated on apical third; in lateral view slightly sinuous, with point internal in position. Accessory plate red, flat, narrowly subtriangular, the posterior margin straight; rounded anteriorly. Claspers dark brown, equal in length, moderately bent; the anterior pair without internal margin, in ventral view with an abrupt basal swelling externally, the apices slightly convergent. Stalk of penis with posterior margin nearly straight in profile, with a fine median groove posteriorly; distal segment of penis moderate in size, with a small, strongly curved, acute claw. Anterior process as large as the body of the segment and closely appressed to it, not excised apically, and with a poorly developed median keel. The sides of both the body of the segment and the anterior process appearing in great part whitish and membranous; the anterior process apparently with no accessory sheath. In ventral view the anterior process appearing massive, with strongly thickened margins.

Female: Unknown.

Holotype male, Rabun Bald, Rabun County, Georgia, August 2, 1952, H. R. Dodge. Type No. 62795, U. S. National Museum.

Paratypes: Four males, same data as type; 6 males, same locality, July 12 and August 12, 1952, H. R. Dodge; 1 male, same locality, April 2, 1953, W. D. Sudia; 1 male, same locality, June 13, 1954, H. R. Dodge.

Variation: The first genital segment is always dark in side view but is usually concolorous with the second segment from above; only one specimen has the first segment wholly black; the first genital segment may lack any indication of a marginal row of bristles. In chaetotaxy, one has a pair of median marginal and five have a single prostrate median marginal bristle on the second tergite.

Idoneamima sutilis (Reinhard), new combination
(FIG. 27)

Sarcophaga sima (in part) Aldrich, 1916, *Sarcophaga* and Allies, pp. 91–92.

Sarcophaga sima Aldrich, Swingle, 1931, 42nd Ann. Rept. Ala. Poly. Inst. p. 49.

Sarcophaga sutilis Reinhard, 1952, Canad. Ent. 84: 144.

Length 8 to 12.5 mm., with one exception, noted later on.

Male: Front at narrowest 0.114 to 0.141 of head width (average 0.127 of five). Metacephalon mostly black haired. Fourth tergite red on posterior margin; first genital segment reddish, pollinose, with a marginal row of about six bristles; second segment red, shining. Forceps red on more than basal half, separated on apical 0.28 of length, in profile curved apically, the point nearly internal in position. Accessory plate red, with a slight umbone at basal third, posterior margin straight on basal two-thirds, anterior margin curved. Claspers brown, unequal, the anterior pair longer, nearly straight, with strong internal margin nearly to tip; in ventral view not thickened basally and with apices parallel. Distal segment of penis with apical claw blunt, not strongly compressed, moderately curved forward, enclosing several rod-shaped processes. Anterior process Y-shaped in anterior view, the arms strongly flattened and curved, the base with a slight median keel and with a whitish oval "window" visible from the sides; sheath absent.

Female: Venter of abdomen subshining, sparsely pollinose.

Holotype: Smith County, Texas, May, 1941, H. J. Reinhard, in Reinhard collection.

Material examined: Thirteen males, Kennesaw Mountain, Cobb County, Georgia, June 17 to September 10, 1952, Sudia and Seago; 201 males and a pair in copulation, same locality, March 16 to May 17, 1953, various collectors; 10 males, Stone Mountain, DeKalb County, Georgia, 1952 and 1953, various collectors; 4 males, same locality, April 9, 1949, P. W. Fattig; 16 males, Graves Mountain, Lincoln County, Georgia, April 3, 1953, J. M. Seago; 1 male, Rabun Bald, Rabun County, Georgia, June 20, 1952, Seago and Sudia; 1 male each, Lula and Albany, Georgia, P. W. Fattig; 1 male, Washington, D. C., July 9, 1916, G. E. Quinter; 2 males, 1 female (ident. "*parallela*" by Hall), College Park, Maryland, September 13, 1916; 1 male, Auburn, Alabama, from *Curculio caryae*, H. S. Swingle (ident. "*sima*" by Aldrich); 1 male, Audubon Park (New Orleans, Louisiana), February 20, 1923; 1 male, Tifton, Georgia, June, 1896,

(paratype of *sima* Aldrich in Chicago Natural History Museum).

Variation: The Auburn, Alabama male and the College Park, Maryland female have the wings strongly infuscated along the veins, but the Rabun Bald male and some of the Kennesaw Mountain series show intergrades of infuscation. With the lack of other characters this variation appears to have no significance. All specimens are red from the apical third of the fourth tergite to the apical third of the forceps, except that some are vaguely blackish on the first genital segment.

The Audubon Park male is unusually small (5 mm.) and red on the apical two-thirds of the fourth tergite, but does not otherwise appear to differ.

Biology: The specimen reported by Swingle was reared under conditions suggesting true parasitism of *Curculio* by this species. The following information on rearing this species is from his letter of September 13, 1952:

"The parasite *Sarcophaga sima* was reared from pecan weevil larvae as follows: the wormy nuts were placed in trays and the larvae collected as they emerged during the period September 23 to October 12, 1929. A total of 675 larvae were placed in hibernation boxes with glass bottoms and screened tops. The screen used was 30 mesh per inch. Holes were made in the sides of the boxes and these were also covered with 30 mesh screen. The boxes were filled with sterile soil to a depth of six inches and the larvae were then introduced. The hibernation boxes were then placed in a screened insectary and buried in the soil to approximately a six inch depth. These boxes were then examined periodically. The parasitic flies were found within the hibernation boxes during the period August to September, 1930. . . ."

This species was especially common in early spring at Kennesaw Mountain, whereas Swingle's specimen and a few others were taken in the fall. Perhaps the host larvae are normally parasitized in the spring as they lie in the soil; perhaps *Curculio* is not the usual host of this insect, or the fly reared by Swingle is specifically different from the author's large series, though a close comparison shows no morphological difference.

This species is very closely related to *tarsata* and *bicolor*.

Idoneamima tarsata (Aldrich), new combination

Sarcophaga tarsata Aldrich, 1916, *Sarcophaga* and Allies, pp. 75–76, fig. 25.

Amblycoryphenes tarsata Townsend, 1938, Manual of Myiology, pt. 6, p. 81.

Length 7 to 9 mm.

Male: Front at narrowest 0.136 to 0.161 of head width (average 0.149 of four). Prosternum setulose or bare. Legs red or yellow, including the coxae but excluding the tarsi; anterior clasper in ventral view not abruptly broadened laterally at base. Otherwise very much like *bicolor*.

Female: Similar to the male except for the usual sexual differences. Front 0.27 of head width. Venter of abdomen sparsely pollinose.

Holotype male and *allotype* female: Miami, Florida, Type No. 20497, U. S. National Museum.

Material examined: Eight males and 13 females in the U. S. National Museum, including the type series, from Miami, Florida, Tifton and McIntosh Counties, Georgia, and Opelousas, Louisiana; 1 male, 1 female in the American Museum of Natural History, Crestview, Florida (paratype, figured by Aldrich) and Homestead, Florida, respectively. In the Chicago Museum are a male paratype, Tifton, Georgia, and 4 males, Opelousas, Louisiana. Professor Fattig has records of this species from Colquitt and Perry, Georgia.

Variation: All specimens of the series have reddish legs but the abdominal red varies more greatly than described for *bicolor*; the venter in the paratype from Crestview is reddish and dark banded, and in the Tifton paratype at Chicago, the venter is almost entirely dark. The anterior acrostichal bristles are fairly well developed in some specimens, but very weak in the type. The costal spine is well developed in this species, and longer than in *bicolor*.

Townsend (1938) erroneously included this species in his genus *Amblycoryphenes*, the description of the male characters for that genus being from this species.

The following species are included in the genus, but have not been available for study, and are not placed in the keys.

Idoneamima acadiana
(Reinhard), new combination
(Figs. 3, 3A, 3B)

Sarcophaga acadiana Reinhard, 1947, J. Kans. Ent. Soc. Soc. 20: 109–110, fig. 14.

Apparently very closely related to *sima*, but with a strongly bowed process (median rod?) before the claw of the penis and with a slight ridge or keel posteriorly at the base of the distal segment of the penis. The type is from Franklin, Louisiana.

Idoneamima elanis (Reinhard), new combination

Sarcophaga elanis Reinhard, 1947, J. Kans. Ent. Soc. 20: 108, fig. 12.

See notes following the description of *monticola*. The type is from Essex County, New York.

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PRELIMINARY STUDIES ON THE TIPHYSINAE OF THE UNITED STATES (ACARINA: PIONIDAE) [1]

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This paper began as a continuation of a study on the subfamilies of the family Pionidae in Michigan[2] but, with the addition of one species not yet taken within this state, was expanded to include all of the known Tiphysinae of the United States. Although there is good reason to believe that this list is far from complete in this area, it will at least form a basis for further work in the group.

At the present time the following six genera and subgenera of Tiphysinae have been reported from this country: *Wettina*, *Hydrochoreutes*, *Tiphys*, *Acercopsis*, *Pionopsis*, and *Pionacercus*, although the validity of the records concerning the latter genus is in doubt. Members of the Tiphysinae do not form a compact unit as do the species of Pioninae and Foreliinae. The subfamily Tiphysinae has been used as a "catch all" for any Pionidae with one common characteristic, having the number of genital acetabula typically three pairs. In an attempt to show the diversity of this group in the classification, three tribes are proposed.

The study of the Tiphysinae presents certain difficulties. Species diagnoses should for the most part be based on the pronounced sexual dimorphism of the males. Females of one species often resemble those of another species and, in certain cases, cannot be placed in the proper genus unless males are known. Unfortunately, males of many species, especially temporary pond forms, may be present in a body of water for only a relatively short time, two or three weeks, and then die out. This means that unless collections are made within a short space of time, males will be missed. Females may be present in a given locality for two or three months, but they are of much less taxonomic value.

Appreciation is expressed to A. J. Besseling, O. Lundblad, and Karl Viets for the gift of European specimens for comparison. Thanks also go to Herbert Habeeb for the loan of specimens of North American Tiphysinae. Three new species are described in the present paper. Holotypes will be deposited in the Chicago Natural History Museum, paratypes in the United States National Museum.

Subfamily **Tiphysinae** Oudemans

Acercinae Viets, 1926. Zool. Anz., 69: 198. (This name invalidated by a change in the name of the type genus from **Acercus** to **Tiphys.**
Tiphysinae Oudemans, 1941. Zool. Anz., 136: 178.
Hydrochoreutinae Viets, 1942. Zool. Anz., 138: 211.

Subfamily Diagnosis: Integument weak, usually without extensive areas of secondary sclerotization (exception: *Pionacercus* males): P-IV typically with a spine-like setae at the distal end (Exception: *Hydrochoreutes*); coxae in four groups; third or fourth pairs of legs usually showing a strong sexual dimorphism in males (exception: *Wettina*); coxae of males greatly expanded and covering most of ventral surface; swimming hairs present; typically there are three pairs of genital acetabula (only known exception is a new species

[1]Contribution from the Department of Biology, Wayne University and the University of Michigan Biological Station. Accepted for publication, May 17, 1955.
[2]A study on the subfamily Foreliinae is scheduled to appear in the June (1955) issue of the Annals of the Entomological Society of America.

of *Tiphys* described in this paper, which has four to six acetabula on each side).

KEY TO THE GENERA, SUBGENERA, AND SPECIES OF TIPHYSINAE KNOWN TO OCCUR IN THE UNITED STATES
based on males only

1. A well developed petiole associated with the genital field (fig. 6); III-Leg-4 highly modified (fig. 22)..... **Hydrochoreutes**
(Only known North American species, **H. intermedius**
Without a petiole; III-Leg-4 unmodified..... 2
2. Third coxae directed posteriorly (fig. 26)....**Wettina**
(Only known North American species,..**W. podagrica**
Third coxae directed transversely..... 3
3. IV-Leg-6 curved or hook-like, with several peg-like setae on concave margin.....**Pionacercus**
(Specimens of **Pionacercus** not yet collected in North America, but members of this genus should occur here).
IV-Leg-6 unmodified, without peg-like setae..... 4
4. IV-Leg-4 not expanded or flattened, approximately same size as IV-Leg-3 (fig. 21).....**Pionopsis**
(Only species.....**P. lutescens**
IV-Leg-4 variously expanded and flattened, larger than IV-Leg-3.....**Tiphys** ..5
5. II-Leg-5 with one or two large spatulate setae (fig. 8).....subgenus **Acercopsis**
(Only known North American species.....**vernalis**
II-Leg-5 without spatulate setae..subgenus **Tiphys** 6
6. Two pairs of setae on fourth coxae slightly anterior to genital bay, coxae not abruptly angled between these setae and the genital bay (fig. 1); few setae present on median surface of IV-Leg-4 (fig. 16).....Ornatus Group 7
One pair of setae on fourth coxae slightly anterior to genital bay, coxae abruptly angled between these setae and the genital bay (fig. 3); a row of setae present on median surface of IV-Leg-4 (figs. 18, 23, 25).....Americanus Group..10
7. IV-Leg-5 inserted at distal end of IV-Leg-4 (figs. 16, 17)..... 8
IV-Leg-5 inserted well back of distal end of IV-Leg-4 (figs. 20, 24)..... 9
8. Swimming hairs at distal end of IV-Leg-5 approximately as long as IV-Leg-6 (fig. 16).....**ornatus**
Swimming hairs at distal end of IV-Leg-5 less than one-half length of IV-Leg-6 (fig. 17).....**brevipes**
9. Length of III-Leg-5 approximately same length as III-Leg-6 (fig. 14).....**T. (T.) marshallae**
Length of III-Leg-5 much less than length of III-Leg-6 (fig. 4).....**T. (T.) scaurus**
10. Three pairs of genital acetabula present.....11
More than three pairs of genital acetabula present (fig. 11).....**T. (T.) mitchelli**
11. IV-Leg-4 greatly expanded (fig. 18).....**T. (T.) americanus**
IV-Leg-4 only slightly expanded (fig. 25).....**T. (T.) diversus**

Tribe **Tiphysini** new tribe

DIAGNOSIS: Sexual dimorphism usually strong, taking the form of modification of the fourth legs in the males; petiole absent; third coxae normal.

TYPE GENUS: *Tiphys* Koch.

INCLUDED GENERA AND SUBGENERA: *Tiphys*, *Pionides*, *Acercopsis*, *Acercella*, *Pionopsis*, *Pionacercus* and *Pionacercopsis*.

Based upon the sexual dimorphism of the males, there are two distinct subdivisions within this tribe. In one subdivision, including *Pionacercus* and *Pionacercopsis*, IV-Leg-6 has become hook-like and some of the setae peg-like similar to that found in the Foreliinae. In the other subdivision, which includes the remaining Tiphysini, IV-Leg-4 shows varying degrees of sexual dimorphism, but IV-Leg-6 remains unmodified. The females belonging to these two subdivisions are unspecialized and, as was mentioned earlier, often cannot be placed in the proper genus unless males are known.

Genus **Tiphys** Koch

Tiphys Koch, 1836. Deutschlands Crust., Myr., Aracyn., Heft 9, no. 19.
Acercus Koch, 1842. Ubers. Arachnidensystems, 3: 23.
Laminipes Piersig, 1901. Zool. Anz., 24: 219.

GENEROTYPE: *Tiphys sagulatus* Koch (this species cannot be recognized, and there is a tendency among present-day workers to accept *T. ornatus* Koch as the generotype).

GENERIC DIAGNOSIS: Integument weak, with a pair of small sclerites on the dorsal surface; typically with three pairs of genital acetabula, although in one species there may be as many as six pairs; the coxae occupy most of the ventral surface in males; in females the coxae are less extensive; IV-Leg-4 exhibiting varying degrees of sexual dimorphism; IV-Leg-5 and 6 little modified.

Subgenus **Tiphys** Koch

SUBGENERIC DIAGNOSIS: IV-Leg-4 broadened and flattened in males; II-Leg-5 without spatulate setae. There are two distinct groups within the North American members of the subgenus.

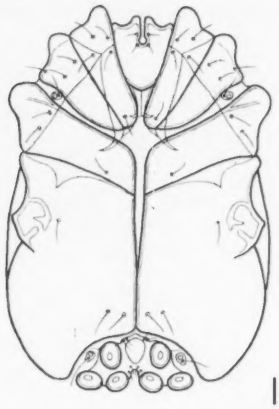
Ornatus Group

DIAGNOSIS: Two pairs of setae on the fourth coxae just anterior to the genital bay; coxae not abruptly angled between these setae and the genital bay; IV-Leg-4 of males without a row of five or more long setae on the median surface.

INCLUDED SPECIES: *Tiphys ornatus* Koch, *T. marshallae* new species, *T. brevipes* Habeeb, and *T. scaurus* (Koenike).

EXPLANATION OF PLATE I

FIG. 1. *Tiphys ornatus* Koch, ventral view, male. FIG. 2. *T. diversus* (Marshall), ventral view, male. FIG. 3 *T. americanus* (Marshall), ventral view, male. FIG. 4 *T. scaurus* (Koenike), end segments of third leg, male. FIG. 5 *Hydrochoreutes intermedius* new species, ventral view, male. FIG. 6 *H. intermedius* new species, genital field, male. FIG. 7 *Pionopsis lutescens* (Hermann), ventral view, male. FIG. 8 *Tiphys vernalis* (Habeeb), end segments of second leg, male. FIG. 9 *Wettina podagrica* (Koch), genital field, male. FIG. 10 *Tiphys ornatus* Koch, end segments of third leg, male. FIG. 11 *T. mitchelli* new species, ventral view, male. FIG. 12 *T. vernalis* (Habeeb), ventral view, male. FIG. 13 *T. brevipes* Habeeb, end segments of third leg, male. FIG. 14 *T. marshallae* new species, end segments of third leg, male. FIG. 15 *T. scaurus*, (Koenike) ventral view, male.



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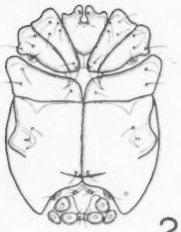

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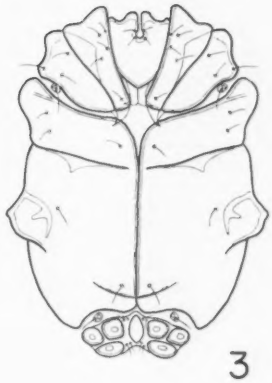

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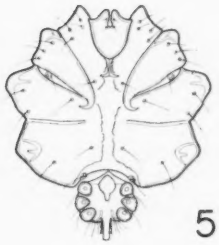

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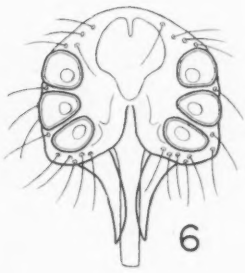

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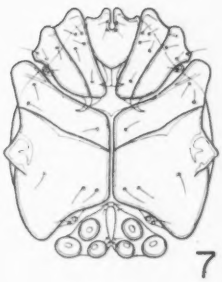

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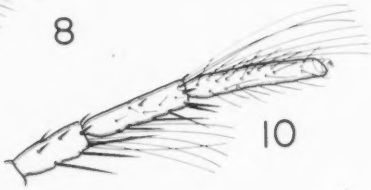

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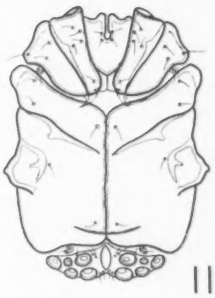

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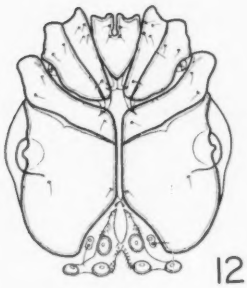

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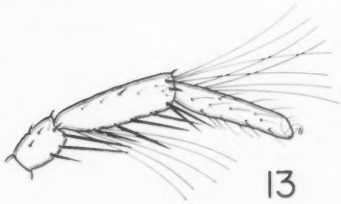

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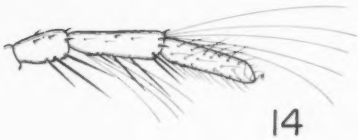

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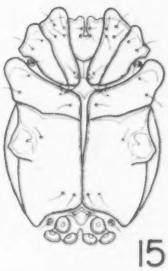

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Tiphys (Tiphys) ornatus Koch

FIGS. 1, 10, 16, 35

T. ornatus Koch, 1836. Deutschlands Crust., Myr., Arachn., Heft 5, no. 20.
Laminipes simulans Marshall, 1924. Trans. Amer. Microsc. Soc., 43: 244.
(?) *Acercus torris americanus* Marshall (in part), 1937. Trans. Wis. Acad. Sci., 30: 237.
Tiphys ornatus Habeeb, 1954. Leaflets Acadian Biol., no. 4, p. 3.

Male: Length of body 0.75–0.88 mm.; body somewhat oval; integument thin, with a single pair of small sclerotized plates on the dorsum; coxal plates occupying most of ventral surface; fourth coxae longer than wide, touching posteriorly but slightly separated anteriorly; two pairs of setae on fourth coxae slightly in front of genital bay; genital bay rounded and moderately deep, not completely inclosing the genital field; three pairs of genital acetabula present; usually with a pair of setae on the acetabular plates laterad to the anterior pair of acetabula.

Length of III-Leg-4, 0.15–0.17 mm.; length of III-Leg-5, 0.20–0.24 mm.; length of III-Leg-6, 0.27–0.30 mm.; swimming hairs present on fourth and fifth segments of third leg; length of IV-Leg-4, 0.25–0.29 mm.; length of IV-Leg-5, 0.31-0.35 mm.; length of IV-Leg-6, 0.37-0.44 mm.; IV-Leg-4 relatively broad and flattened, with IV-Leg-5 inserted near the distal end; swimming hairs at distal end of IV-Leg-5 approximately same length as IV-Leg-6.

Female: Length between anterior end of first coxae and posterior end of fourth coxae 0.76–0.82 mm.; body rounded; integument thin, with a single pair of sclerotized plates on the dorsum; genital acetabula arranged in an arc, with the acetabula occupying most of the acetabular plate; fifth and sixth segments of first leg approximately same length; I-Leg-5, 0.36–0.40 mm.; I-Leg-6, 0.36–0.39 mm.

Habitat: Temporary ponds and marshy areas of lakes which are subject to periodic drying.

Range: Holarctic; this species has been found in Europe, North Africa, Asia, Alaska, Michigan, New Jersey, and Wisconsin.

Remarks: Specimens of *T. ornatus* from Germany and Sweden were compared with examples from Michigan and found to agree very closely. Marshall (1924) described *Tiphys* females from Alaska under the name *Laminipes simulans*. An examination of the cotypes of *simulans* shows them to be females of *ornatus*. The female specimens described by Marshall (1937) as *Acercus torris americanus* are either *ornatus* or one of the *ornatus*-group.

Males of *T. ornatus* may be separated from other members of its group by the following combination of characters: III-Leg-4 is much longer (0.15–0.17 mm.); IV-Leg-5 is inserted near the distal end of IV-Leg-4; swimming hairs at the distal end of IV-Leg-5 approximately as long as IV-Leg-6.

Tiphys (Tiphys) marshallae new species

Figs. 14, 20

Male: Length of body 0.70–0.82 mm.; body oval; integument very thin, with a pair of small sclerotized plates on the dorsum; coxae occupying most of the ventral surface; fourth coxae touching each other near posterior end, slightly separated at anterior end; two pairs of setae on fourth coxae slightly in front of genital bay; three pairs of genital acetabula present; usually with a pair of setae on the acetabular plates posterior to the anterior pair of acetabula.

Length of III-Leg-4, 0.10–0.12 mm.; length of III-Leg-5, 0.18–0.21 mm.; length of III-Leg-6, 0.19–0.22 mm.; swimming hairs present on fourth and fifth segments of third leg; length of IV-Leg-4, 0.24–0.28 mm.; length of IV-Leg-5, 0.33–0.37 mm.; length of IV-Leg-6, 0.35–0.47 mm.; IV-Leg-4 very broad, with IV-Leg-5 inserted well in front of distal end; swimming hairs at distal end of IV-Leg-5 about one-half length of IV-Leg-6.

Female: Similar to females of *T. ornatus*, except that the integument and sclerotization of the present species is much thinner.

TYPES: *Holotype*, adult male, collected in an overflow area (temporary pond conditions) of Wall Lake, Barry County, Michigan (T2N/R9W/S29) on April 14, 1951; *allotype*, adult female, same data as holotype; *paratypes*, seven males, two females, same data as holotype; eight males, six females, taken in a temporary pond near Big Star Lake, Lake County, Michigan (T17 N/R14W/S25) on May 2, 1951; one male, collected in a tamarack bog (temporary pond conditions) in Livingston County, Michigan (T1N/R4E/S14) on April 16, 1952.

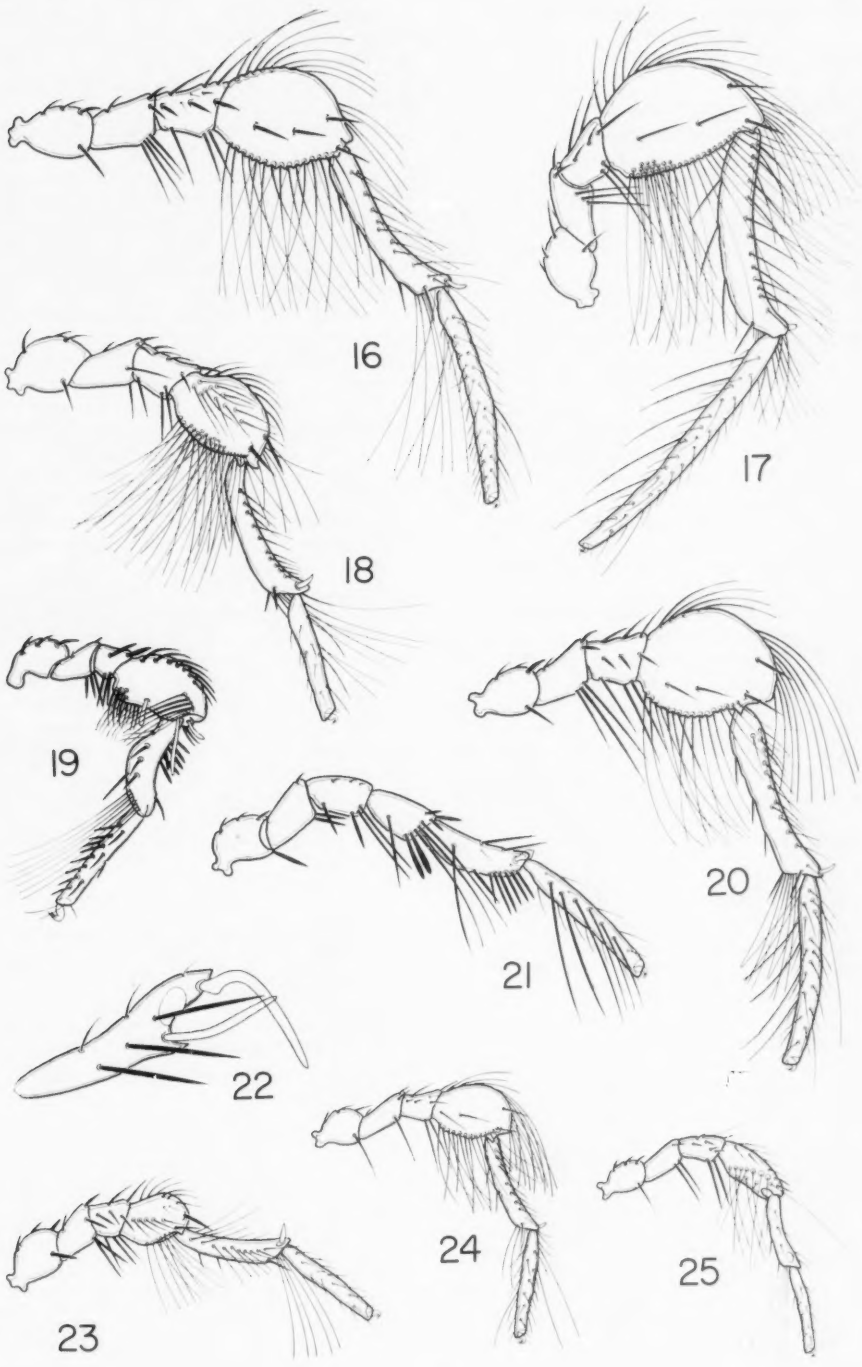
Habitat: Same as *T. ornatus*.

Range: At present, this species is known only from the lower peninsula of Michigan.

Remarks: Males of *T. marshallae* may be separated from other members of the *ornatus*-group by the following combination of characters: IV-Leg-4 relatively short (0.10–0.12 mm. in length); IV-Leg-5 inserted well before the distal end of IV-Leg-4; swimming hairs at the distal end of IV-Leg-5 about one-half length of IV-Leg-6. Females of *marshallae* resemble females of *ornatus* but are much more weakly sclerotized.

EXPLANATION OF PLATE II

FIG. 16 *Tiphys ornatus* Koch, fourth leg, male. FIG. 17 *T. brevipes* Habeeb, fourth leg, male. FIG. 18 *T. americanus* (Marshall), fourth leg, male. *Fig.* 19 *T. vernalis* (Habeeb), fourth leg, male. FIG. 20 *T. marshallae* new species, fourth leg, male. FIG. 21 *Pionopsis lutescens* (Hermann), fourth leg, male. FIG. 22 *Hydrochoreutes intermedius* new species, fourth segment of third leg, male. FIG. 23 *Tiphys mitchelli* new species, fourth leg, male. FIG. 24 *T. scaurus* (Koenike), fourth leg, male. FIG. 25 *T. diversus* (Marshall), fourth leg, male.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Tiphys (Tiphys) brevipes Habeeb[3]

Figs. 13, 17

T. brevipes Habeeb, 1954. Leaflets Acadian Biol., no. 4, p. 3.

Male: Length of body 66–80 mm.; body oval; integument thin, with a pair of small sclerotized plates on the dorsum; coxae occupying most of the ventral surface; fourth coxae touching each other near posterior end, separated at anterior end; two pairs of setae on fourth coxae slightly anterior to the genital bay; three pairs of genital acetabula present.

Length of III-Leg-4, 0.10–0.12 mm.; length of III-Leg-5, 0.19–0.23 mm.; length of III-Leg-6, 0.18–0.26 mm.; swimming hairs present on fourth and fifth segments of third leg; length of IV-Leg-4, 0.26–0.34 mm.; length of IV-Leg-5, 0.35–0.42 mm.; length of IV-Leg-6, 0.38–0.61 mm.; IV-Leg-4 broadened; IV-Leg-5 inserted near distal end of IV-Leg-4; swimming hairs at distal end of IV-Leg-5 very short, about one-fourth length of IV-Leg-6.

Female: Similar to females of *T. ornatus*.

Habitat: Same as *T. ornatus*.

Range: Known from Michigan and New Brunswick, Canada.

Remarks: The following combination of characters will separate *brevipes* from the rest of the *ornatus*-group males: III-Leg-4 short, 0.10–0.12 mm. in length; IV-Leg-4 large, somewhat truncate on ventral side; IV-Leg-5 inserted at distal end of IV-Leg-4; swimming hairs at distal end of IV-Leg-5 very short, approximately one-fourth length of IV-Leg-6. Although there is considerable variation in the length of IV-Leg-6, the fourth leg of *T. brevipes* is usually the longest of any of the *ornatus*-group.

Tiphys (Tiphys) scaurus (Koenike)

Figs. 4, 15, 24, 33

Piona scaura Koenike, 1892. Zool. Anz., 15: 266.
Tiphys scaurus Habeeb, 1954. Leaflets Acadian Biol., no. 4, p. 3.

Male: Length of body 0.46–0.53 mm.; body oval; integument thin, with a pair of small sclerotized plates on the dorsum; coxal plates occupying most of ventral surface; fourth coxae touching each other posteriorly, slightly separated anteriorly; two pairs of setae present on fourth coxae slightly anterior to the genital bay; genital bay shallow, most of genital field lying outside genital bay; three pairs of genital acetabula present.

Length of III-Leg-4, 0.080–0.084 mm.; length of III-Leg-5, 0.096–0.112 mm.; length of III-Leg-6, 0.159–0.172 mm.; swimming hairs present on fourth and fifth segments of third leg; length of IV-Leg-4, 0.136–0.152 mm.; length of IV-Leg-5, 0.188–0.208 mm.; length of IV-Leg-6, 0.200–0.225 mm.; IV-Leg-5 inserted well back of distal end of IV-Leg-4.

Female: (not taken in Michigan; the following measurements are based on specimens from the Netherlands, kindly supplied the author by Dr. A. J. Besseling) Length between anterior margin of first coxae and posterior margin of fourth coxae 0.38–0.42 mm.; body rounded; integument thin, with a pair of small sclerotized plates on the dorsum; acetabular plates shaped somewhat like those of *T. ornatus* females, except that in the present species they are smaller and are much shorter in length than the genital opening; length of I-Leg-5, 0.168–0.171 mm.; length of I-Leg-6, 0.172–0.194 mm.

Habitat: Similar to that of *T. ornatus*.

Range: Holarctic; this species is widely distributed in Europe and has been reported from Japan. In this country, *T. scaurus* has been collected in Michigan and New Jersey.

Remarks: Males of *T. scaurus* may be separated from other species in the ornatus-group by its much smaller size, comparatively shorter fourth coxae, and swallower genital bay. Females of the present species differ in having the acetabular plates much shorter than the genital opening.

Americanus group

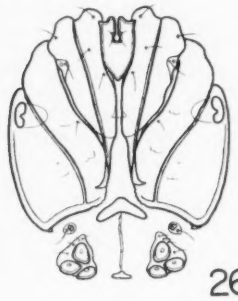
DIAGNOSIS: One pair of setae on the fourth coxae slightly anterior to the genital bay; coxae abruptly angled between these setae and the genital bay; IV-Leg of males with a row of five or more long setae on the median surface.

INCLUDED SPECIES: *Tiphys americanus* (Marshall), *T. mitchelli* new species, and *T. diversus* (Marshall).

[3]Shortly after this manuscript was submitted, Habeeb (1955, Leaflets Acadian Biol., no. 5, p. 4) published a new name for *Tiphys brevipes*, calling it *Tiphys Vietsi* n. nov. Habeeb apparently based the name change on the fact that Piersig (1901, Das Tierreich, Hydrachnidae und Halacaridae 13 Lieferung, p. 242) listed a *Tiphys brevipes* (Neuman) and felt that *Tiphys brevipes* Habeeb was a homonym. However, Neuman's species was originally published as *Nesaea brevipes* Neuman (1880, Kongl. Svenska Vetenskaps-Akademiens Handlingar, n. ser., (4), 17(3): 49). Lundblad (1954, Entomologisk Tidskrift 75: 44–60) re-examined Neuman's specimens and found that his *Nesaea brevipes* was actually a *Forelia*. Therefore, *Tiphys brevipes* Habeeb is valid and *T. vietsi* becomes a junior synonym.

EXPLANATION OF PLATE III

FIG. 26 *Wettina podagrica* (Koch), ventral view, female. FIG. 27 *Tiphys diversus* (Marshall), ventral view, female. FIG. 28 *T. vernalis* (Habeeb), ventral view, female. FIG. 29 *Pionopsis lutescens* (Hermann), ventral view, female. FIG. 30 *Hydrochoreutes intermedius* new species, palp, female. FIG. 31 *H. intermedius* new species, ventral view, female. FIG. 32 *Wettina podagrica* (Koch), first leg, female. FIG. 33 *Tiphys scaurus* (Koenike), genital field, female. FIG. 34 *Wettina podagrica* (Koch), palp, female. FIG. 35 *Tiphys ornatus* Koch, ventral view, female. FIG. 36 *T. americanus* (Marshall), ventral view, female



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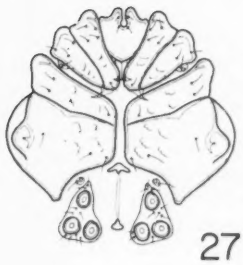

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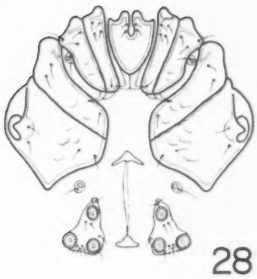

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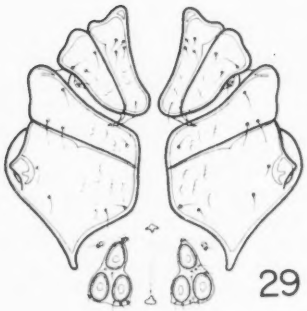

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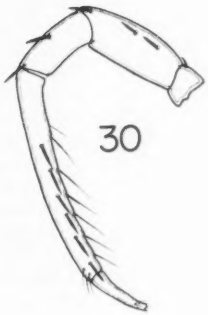

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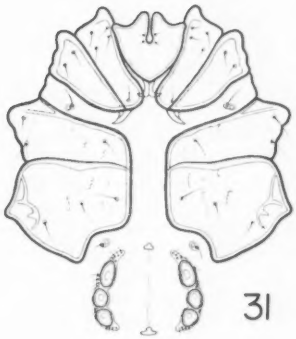

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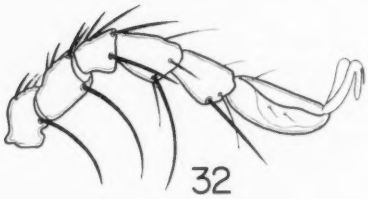

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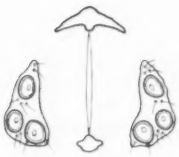

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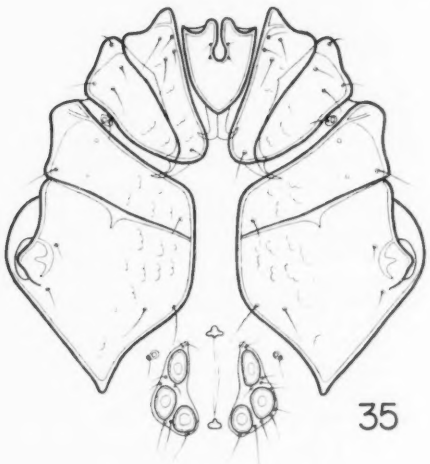

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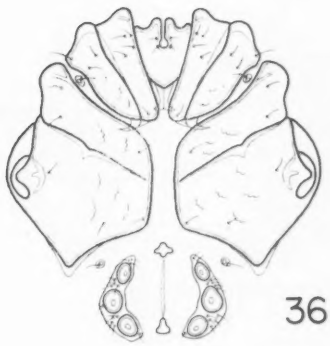

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Tiphys (Tiphys) americanus (Marshall)

Figs. 3, 18, 36

Acercus torris americanus Marshall (in part), 1937. Trans. Wis. Acad. Sci., 30: 237.

Tiphys curvipes Habeeb, 1954. Leaflets Acadian Biol., no. 4, p. 1.

Male: Length of body 0.62–0.74 mm.; body oval; integument thin, with a pair of small sclerotized plates on the dorsum; coxal plates covering most of ventral surface; fourth coxae touching each other along entire length; a single pair of setae present slightly anterior to the genital bay; fourth coxae abruptly angled posterior to these setae, appearing as a curved line when viewed from the ventral side; genital bay rather shallow; three pairs of genital acetabula present, these arranged as two anterior pairs and one posterior pair; posterior acetabula largest.

Length of III-Leg-5, 0.192–0.210 mm.; length of III-Leg-6, 0.175–0.209 mm.; swimming hairs present on fourth and fifth segments of third leg; length of IV-Leg-4, 0.193–0.218 mm.; length of IV-Leg-5, 0.279–0.297 mm.; length of IV-Leg-6, 0.217–0.244 mm.; IV-Leg-4 expanded and flattened, with numerous setae on the lateral surface.

Female: Length between anterior end of first coxae and posterior end of fourth coxae 0.47–0.53 mm.; body rounded; integument thin, with a pair of small sclerotized plates on the dorsum; three pairs of genital acetabula present, these located on crescent-shaped acetabular plates; acetabula small, not occupying most of acetabular plates; fourth coxae approximately as wide as long; length of I-Leg-5, 0.192–0.210 mm.; length of I-Leg-6, 0.226–0.279 mm.

Habitat: Temporary and semipermanent ponds, and the backwater areas of lakes subjected to summer drying.

Range: Marshall (1937) reported this species from Illinois and Wisconsin. *T. americanus* has since been collected in Michigan, Maine, and New Jersey. Bergstrom (1953) listed this species from lakes in Wyoming. Since, however, *T. americanus* seems to be restricted to temporary and semipermanent bodies of water and the Wyoming specimens came from lakes, the identity of the western mites needs confirming.

Remarks: Marshall (1937) considered *americanus* to be a subspecies of the European species, *T. torris* (O. F. Muller). However, the abruptly angled posterior part of the fourth coxae and the associated single pair of setae show that *T. americanus* is rather distantly related to *torris* and should stand as a distinct species. The female *Tiphys* figured by Marshall (1937) is not the female of *americanus* but is probably *ornatus*.

Tiphys (Tiphys) mitchelli new species

Figs. 11, 23

Male: Length of body 0.48–0.54 mm.; body oval; integument thin, with a pair of small sclerotized plates on the dorsal side; coxae occupying most of ventral surface; fourth coxae touching each other along entire length; one pair of setae present near posterior end of fourth coxae; fourth coxae abruptly angled posterior to these setae; genital bay very shallow, not enclosing the genital field; four to six genital acetabula present on each side, with five acetabula the most common number.

Length of III-Leg-5, 0.149–0.156 mm.; length of III-Leg-6, 0.160–0.176 mm.; a few swimming hairs present on fourth and fifth segments of the third leg; length of IV-Leg-4, 0.112–0.124 mm.; length of IV-Leg-5, 0.208–0.228 mm.; length of IV-Leg-6, 0.196–0.220 mm.; IV-Leg-4 not greatly enlarged or flattened, only slightly larger than IV-Leg-1; IV-Leg-4 with a row of setae on lateral surface.

Female: Unknown.

TYPES: *Holotype*, adult male, collected in a tamarack bog (temporary pond conditions) in Livingston County, Michigan (T1N/R4E/S14) on March 19, 1952.

Paratypes, two males, same data; one male, same locality on April 16, 1952.

Habitat: Temporary ponds.

Range: Known only from the type locality.

Remarks: The most distinctive character of *T. mitchelli* is its possession of four to six pairs of genital acetabula. Until the discovery of this species, one of the primary characteristics of the subfamily Tiphysinae was thought to be possession of only three pairs of acetabula. The tendency among water mite workers has been to establish subgenera on the basis of number of acetabula present. By this criterion, the present species should be placed in a separate subgenus. To do this, however, would mean ignoring the many similarities which relate it closely to *T. americanus* in favor of a single character, that of the number of acetabula. In a great number of water mite genera, in which the number of genital acetabula is typically three pairs, species are found with four to many pairs of acetabula. This means that modifications towards polyacetabulism have occured many times and suggests that it is a relatively easy evolutionary step from few to many acetabula. For this reason, the author rejects the number of acetabula as a basis for subgeneric splitting unless backed up by other characters.

Although a large number of collections were made at the type locality over a three-year period, no polyacetabulate *Tiphys* females were taken. The possibility exists that only the males of the present species have more than three pairs of acetabula and that the author is confusing the females of *mitchelli* with females of other species.

Tiphys (Tiphys) diversus (Marshall)

Figs. 2, 25, 27

Acerus [=*Acercus*] *diversus* Marshall, 1929. Univ. Toronto Stud., Biol. Ser., no. 33, p. 83.

Male: Length of body 0.40–0.45 mm.; body oval; integument thin, with a single pair of small sclerotized plates on the dorsum; coxal plates occupying most of ventral surface; fourth coxae touching along entire length; a single pair of setae present on fourth coxae slightly anterior to the genital bay; fourth coxae abruptly angled posterior to these setae; genital bay relatively deep, almost completely enclosing the genital field; three pairs of genital acetabula present.

Length of III-Leg-5, 0.124–0.135 mm.; length of III-Leg-6, 0.127–0.133 mm.; swimming hairs present on fourth and fifth segments of third leg; length of IV-Leg-4, 0.139–0.144 mm.; length of IV-Leg-5, 0.160–0.164 mm.; length of IV-Leg-6, 0.160–0.165 mm., IV-Leg-4 only slightly widened and flattened, with a row of long setae running diagonally across the lateral surface; a small oval clear area (probably a setal base) present at distal end of IV-Leg-5.

Female: Length between anterior margin of first coxae and posterior margin of fourth coxae 0.33–0.37 mm.; body rounded; integument thin, with a pair of small sclerotized plates on the dorsum; three pairs of genital acetabula present, these located on triangular-shaped acetabular plates; fourth coxae much shorter than wide; length of I-Leg-5, 0.140–0.164 mm.; length of I-Leg-6, 0.139–0.160 mm.

Habitat: Unlike most other species of *Tiphys* known from North America, *T. diversus* has been found primarily in lakes and permanent ponds. The author has one collection of this species from an overflow area of Black Lake, Cheyboygan County, Michigan (temporary pond conditions). In Douglas Lake, Cheboygan County, Michigan, *diversus* was taken at a depth of nine feet.

Range: Known from Ontario and widely scattered localities in both peninsulas of Michigan.

Remarks: Males of *Tiphys diversus* may easily be separated from males of other species of *Tiphys* known from this country by their less highly modified IV-Leg-4. The female of the present species may be distinguished by its small size, triangular acetabular plates, and relatively short fourth coxae.

Subgenus **Acercopsis** Viets

Acercopsis Viets, 1926. Zool. Anz., 69: 195.
Freemania Halbert, 1944. Proc. Royal Irish Acad., 50B (4): 84.

SUBGENEROTYPE: *Tiphys* (*Acercopsis*) *pistillifer* (Koenike)

Subgeneric Diagnosis: IV-Leg-4 broadened in males; II-Leg-5 with one or two spatulate setae.

Halbert (1944) erected *Freemania*, stating that it differed from *Acercopsis* in certain details of IV-Leg-4. In a group of mites such as *Tiphys sensu lato*, in which one of the primary characteristics is the pronounced modification of IV-Leg-4, these differences do not seem to be of more than specific value. For this reason, the author feels that *Freemania* Halbert should be considered a synonym of *Acercopsis* Viets.

Tiphys (**Acercopsis**) **vernalis** (Habeeb)

Figs. 8, 12, 19, 28

Acercopsis vernalis Habeeb, 1954. Leaflets Acadian Biol., no. 4, p. 1.

Male: (based on a single specimen) Length of body 0.61 mm.; body oval; integument weak, with two pairs of small sclerotized plates on the dorsum; coxae covering most of ventral surface; fourth coxae separated; genital bay triangular, moderately deep; three pairs of genital acetabula; acetabular plate attenuated, extending posteriorly to region of second acetabula and then laterally to third acetabula; numerous small setae present on acetabular plates between genital opening and the second acetabula.

II-Leg-2 with a rounded hump on the ventral side; II-Leg-5 with two spatulate setae, the smallest of these setae inserted at the disto-ventral end, the largest inserted ventrally and slightly distal to the middle of the segment; length of III-Leg-4, 0.09 mm.; length of III-Leg-5, 0.12 mm.; length of III-Leg-5, 0.16 mm.; swimming hairs present on III-Leg-5; length of IV-Leg-4, 0.18 mm.; length of IV-Leg-5, 0.19 mm.; length of IV-Leg-6, 0.25 mm.; IV-Leg-4 slightly convex on ventral side; IV-Leg-5 inserted well in front of distal end of IV-Leg-4; a short, stout seta present slightly distal to insertion of IV-Leg-5; dorsal setae of IV-Leg-4 spine-like, swimming hairs on ventral side of this segment very short; IV-Leg-5 greatly widened near middle.

Female: Length between anterior end of first coxae and posterior end of fourth coxae 0.35–0.42 mm.; body rounded; integument thin, with two pairs of small sclerotized plates on the dorsum; genital acetabula arranged in the form of a triangle; genital acetabula small, occupying about one-half area of acetabular plates; length of acetabular plates approximately one-half length of genital opening; fourth coxae short; length of I-Leg-5, 0.11–0.14 mm.; length of I-Leg-6, 0.14–0.17 mm.

Habitat: Temporary ponds.

Range: Known from Michigan and New Jersey.

Remarks: Males of *T. vernalis* can be distinguished from males of the European species, *pistillifer* on the following characters: *vernalis* has two spatulate setae on II-Leg-5 instead of one, and the acetabular plates of the North American species are much longer and narrower.

Genus **Pionopsis** Piersig

Pionopsis Piersig, 1894. Zool. Anz., 17: 216.

GENEROTYPE: *Pionopsis lutescens* (Hermann)

Generic Diagnosis: Integument weak; three pairs of genital acetabula present; IV-Leg-4 of male not expanded and flattened, approximately same size as IV-Leg-3; IV-Leg-6 relatively un-

modified; sexual dimorphism largely confined to thickening of the setae in the male.

Pionopsis lutescens (Hermann)

Figs. 7, 21, 29

Hydrachne lutescens Hermann, 1894. Mem. Apterologique, p. 57.

Male: Length of body 0.48–0.54 mm.; body oval, integument thin; fourth coxae approximately as long as wide; two pairs of setae on fourth coxae slightly anterior to genital bay; genital bay moderately deep; three pairs of genital acetabula; no secondary sclerotization in the region of the acetabular plates; genital opening long and narrow.

Length of III-Leg-5, 0.15–0.17 mm.; length of III-Leg-6, 0.20–0.22 mm.; swimming hairs present on fourth and fifth segments of third leg; IV-Leg-4 short and not flattened, with two blade-like setae and three long, hair-like setae at distal end; IV-Leg-5 with one long, hair-like seta near proximal end and six or seven shorter setae in a row along disto-ventral end; IV-Leg-6 with five to seven long, hair-like setae.

Female: Length between anterior margin of first coxae and posterior margin of fourth coxae 0.56–0.66 mm.; body rounded, integument thin; genital acetabula arranged in the form of a triangle; posterior corners of fourth coxae sharply angled; length of I-Leg-5, 0.25–0.26 mm.; length of I-Leg-6, 0.26–0.27 mm.

Habitat: In Michigan, this species has been taken only in temporary ponds. In Europe, however, *P. lutescens* has been collected in various types of permanent standing water.

Range: Holarctic; known from North Africa, Europe, Asia and eastern North America.

Remarks: Specimens of *P. lutescens* from North America differ from the individuals from Germany and Holland which were examined by the author in that the Old World mites had extensive secondary sclerotization in the region of the genital field while our mites lack this. If it can be demonstrated that this is a constant difference, the North American form should probably be set up as a distinct subspecies. One subspecies and two additional species of *Pionopsis* have been described from North America. The exact taxonomic status of these mites is in doubt and the following remarks should be regarded as tentative until more data concerning them is at hand. Marshall (1924) described *P. latilamellis* from Alaska. Her diagnosis is based on the female only, and until males are collected at or near the type locality, it is impossible to know for sure whether *latilamellis* is a valid species, subspecies or only a synonym of *lutescens*. If, however, the New World *P. lutescens* should prove to be a distinct subspecies and the Alaskan form is found to be similar to *lutescens* from Michigan, *latilamellis* will be the valid subspecific name. Habeeb (1954) gave the name *P. fragilis* to some *Pionopsis* males from New Brunswick. They differ from the Michigan specimens of *lutescens* in being somewhat smaller, possessing slightly stockier appendages, and having the acetabular plates proportionally narrower. The chaetotaxy of *fragilis* is similar to that of *lutescens*. Although specific status does not seem to be justified, *fragilis* may prove to be a valid subspecies. However, little can be done with subspecific taxonomy until large series of *Pionopsis* are collected from other parts of North America. Habeeb (1954) also described *P. lutescens paludis* from specimens taken in a swamp in New Jersey. Habeeb states that *paludis* is "distinct in that the acetabulae are larger, especially the anterior acetabula on each side of the genital orfice". He gives no measurements of the acetabula and, in view of the considerable variation in size of the acetabula to be found within single populations of *lutescens*, it is difficult to believe that this subspecies is valid.

Genus **Pionacercus** Piersig

Pionacercus Piersig, 1894. Zool. Anz., 17: 213.

GENEROTYPE: *Pionacercus leuckarti* Piersig

Generic Diagnosis: Integument thin, with a pair of small sclerotized plates on the dorsum in females; extensive dorsal sclerotization present in males of some species; three pairs of genital acetabula; IV-Leg-6 of males curved or hook-like, with several peg-like setae on the concave side.

There have been two reports of *Pionacercus* from North America, both of which seem to be based on misidentifications. Marshall (1924) described *Pionacercus novus* from Alaska. An examination of the type of *novus* confirmed what was suspected from Marshall's drawings, that *P. novus* is actually the nymphal stage of one of the large species of *Piona*. Moore (1939), during the course of his studies on the microscopic benthic fauna of Douglas Lake, Michigan, collected several hydrachnids which were sent to Ruth Marshall for identification. Among these mites was a female (now unfortunately lost) which Marshall called an undescribed species of *Pionacercus*. Extensive collections made by the present author in Douglas Lake during a four year period from 1949 to 1952 did not yield any specimens of *Pionacercus*. However, numerous individuals of *Tiphys diversus* were taken. The acetabular plates of *diversus* females are triangular, giving them a superficial resemblance to *Pionacercus* females and it is probable that Marshall was dealing with *T. diversus*, of which she had never recognized the females.

Although the previous records of *Pionacercus* in North America seem to be in error, the genus is very widespread in the old world, and there is good reason to believe that it will turn up in future collections from this country.

Tribe **Hydrochoreutini** new tribe

DIAGNOSIS: Sexual dimorphism strong, taking the form of modification of III-Leg-4 and the development of a petiole in males; third coxae normal.

Type Genus: Hydrochoreutes Koch (only included genus)

Genus **Hydrochoreutes** Koch

Hydrochoreutes Koch, 1837. Deutschlands Crust., Myr., Arachn., Heft 11, no. 9.

GENEROTYPE: *Hydrochoreutes ungulatus* (Koch)

Generic Diagnosis: Integument weak; palpi and legs extremely long in both sexes; palpi without a projection at the distal end of the fourth segment; III-Leg-4 of male showing strong sexual dimorphism; coxae fused in male, separated into four groups in female; three pairs of genital acetabula present; a petiole associated with the genital field in males.

Hydrochereutes intermedius new species

Figs. 5, 6, 22, 30, 31

Hydrochoreutes ungulatus Marshall, 1937. Trans. Wis. Acad. Sci., 30: 236.

Male: Length of body, including petiole, 0.42–0.62 mm.; body proper somewhat truncate at posterior end; coxal plates fused with secondary sclerotization medially; fourth coxae much wider than long; genital bay very shallow; genital field at posterior end of body; three pairs of genital acetabula present; petiole as long as acetabular plates; petiole flanked by two side pieces, petiole extending more than its own width beyond the side pieces.

Length of III-Leg-4, 0.21–2.28 mm.; III-Leg-4 with two greatly thickened setae; thickened seta at distal end curved 90 degrees, length 0.11–0.14 mm.; the more proximally located thickened seta slightly curved, 0.10–0.13 mm. in length; one long unmodified seta between the thickened setae and two long unmodified setae proximal to the thickened setae; palpi very long; length of P-I, 0.032–0.044 mm.; length of P-II, 0.108–0.144 mm.; length of P-III, 0.076–0.092 mm.; length of P-IV, 0.188–0.248 mm.; length of P-V, 0.064–0.088 mm.

Female: Length between anterior margin of first coxae and posterior margin of fourth coxae 0.44–0.59 mm.; body rounded, integument thin; genital acetabula arranged in an arc, with the acetabula occupying most of the acetabular plates; palpi similar to those of male except that they are larger; Length of I-Leg-5, 0.35–0.54 mm.; length of I-Leg-6, 0.30–0.42 mm.

TYPES: *Holotype*, adult male, collected in the Polson Bay area of Flathead Lake, Lake County, Montana, on June 29, 1954; *allotype*, adult female, same data as holotype; *paratypes*, 14 males, six females, same data as holotype; two males, two females, taken at Hook Point, Douglas Lake, Cheboygan County, Michigan (T37N/R3W/S22) on July 1, 1952; three males, four females, collected at the mouth of Bessey Creek, Douglas Lake, Cheboygan County, Michigan (T37N/R3W/S18) on August 6, 1949.

Habitat: Found in lakes and sluggish streams.

Range: The author has taken *H. intermedius* in Montana and Michigan. Marshall (1937) recorded *H. ungulatus* from Maine, Michigan, Wisconsin and California. Marshall's figure of III-Leg-4 of the Wisconsin specimen is identical with that of *intermedius*. The specimens from Maine and California have not been seen by the present author but it is very possible that they should also be assigned to the new species.

REMARKS: *Hydrochoreutes intermedius* may be separated from the two European species, *H. ungulatus* (Koch) and *H. krameri* Piersig, by differences in III-Leg 4 of the males. III-Leg-4 of *intermedius* differs from that of *ungulatus* in being somewhat stockier, and having two rather than four long unmodified setae proximal to the thickened setae. III-Leg-4 of the North American species differs from III-Leg-4 of *krameri* in being proportionally longer, having the bases of the two long unmodified setae proximal to the thickened setae somewhat removed from each other, and having the more proximal of the thickened setae approximately as long as the distal thickened seta.

Tribe **Wettini** new tribe

DIAGNOSIS: Appendages not exhibiting sexual dimorphism; third coxae directed posteriorly; males without a petiole.

TYPE GENUS: *Wettina* Piersig (only included genus)

Genus **Wettina** Piersig

Wettina Piersig, 1882. Zool. Anz., 15: 410.

GENEROTYPE: *Wettina podagrica* (Koch)

GENERIC DIAGNOSIS: Integument weak, with a pair of small sclerites on the dorsal surface; appendages not showing sexual dimorphism; three pairs of genital acetabula; third coxae directed posteriorly; apodemes between third and fourth coxae not touching the median line; apodemes from the first coxae extending almost to the posterior border of the third coxae; segments of the first leg expanded, claws very large; second, third and fourth legs fitted with long swimming hairs.

Wettina podagrica (Koch)

Figs. 9, 26, 32, 34

Tiphys podagricus Koch, 1837. Deutschlands Crust., Myr., Arachn., Heft 11, no. 9.

Wettina primaria Marshall, 1929. Univ. Toronto Stud., Biol. Ser., no. 33, p. 83.

Female: (measurements based on a single specimen from Montana) Length between anterior end of first coxae and posterior end of fourth coxae

0.42 mm.; body oval, integument thin, with a pair of small sclerotized plates on the dorsum; three pairs of genital acetabula, these arranged in an arc (figure 26 shows the acetabular plates much foreshortened, due to the curvature of the body at the posterior end); first leg modified for crawling, claws and claw socket large; length of I-Leg-4, 0.072 mm.; length of I-Leg-5, 0.071 mm.; length of I-Leg-6, 0.112 mm.; figure 32 shows the chaetotaxy of the first leg; second, third and fourth legs modified for swimming; dorsal lengths of the palpal segments were: P-I, 0.036 mm.; P-II, 0.078 mm.; P-III, 0.056 mm.; P-IV, 0.092 mm.; P-V, 0.042 mm.; a moderately long seta present at the distal end of P-IV.

Male: There is little difference between the two sexes except in structure of the genital field. Figure 9 illustrates the acetabular plates of a European specimen of *W. podagrica*, kindly supplied the author by Dr. O. Lundblad.

Habitat: Streams and the backwater areas of rivers.

Range: Holarctic; in the United States, this species has been taken only in a backwater area of the Swan River, Flathead County, Montana. Marshall (1929) described *W. primaria*, which the present author considers to be a synonym of *W. podagrica*, from the Nipigon River, Ontario.

Remarks: The female specimen of *Wettina podagrica* from Montana differs from European specimens in being smaller and, compared with the one European female seen by the author, has a proportionally narrower pregenital sclerite. Marshall (1929) described a male *Wettina* from Ontario under the name *W. primaria*, stating that it differed from the European species in being smaller and having the coxal plates relatively broader. The coxal plates of *Wettina* curve part way up the sides of the body, so that the apparent width of these plates depends upon how much the mite has been flattened during slide making. Based on present evidence, it would seem best to consider *W. primaria* as a synonym of *W. podagrica*.

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AROMATIC ESTERASE IN INSECTS[1,2]

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The presence in *Tenebrio molitor* of an enzyme which is active in hydrolyzing *o*-nitrophenyl acetate has been established by Lord and Potter (1951), and this enzyme has been shown to be present in the tissues of a number of insects. However, no information is available regarding its properties and normal physiological functions.

Detailed studies of enzymes in vertebrate blood and tissues which hydrolyze phenyl esters have recently been made by Mounter and Whittaker (1953) and by Aldridge (1953). These authors have shown that various substituted phenyl esters are hydrolyzed by at least five esterases in human blood; erythrocyte acetylcholinesterase, plasma butyrylcholine esterase, aliphatic or ali-esterase or B-esterase, erythrocyte aromatic esterase or A-esterase, and plasma aromatic esterase. The last two may be a single enzyme. The hydrolysis of aromatic esters by the cholinesterases and ali-esterase is highly sensitive to eserine and diethyl *p*-nitrophenyl phosphate (para-oxon), but the aromatic esterase is very resistant to these inhibitors.

We became interested in insect aromatic esterase (ArE) as a result of studies of the substrate preferences of crude cholinesterase (ChE) preparations from breis of house-fly and honeybee heads. It was found (Metcalf *et al.*, 1955) that these breis in addition to hydrolyzing a variety of choline and other aliphatic esters, hydrolyzed phenyl acetate (PhAc) at rates often greater than those of any of the aliphatic esters studied. Preliminary experiments with selective inhibition and competitive substrates indicated that a distinct aromatic esterase was partially responsible for at least a portion of the hydrolysis of the PhAc.

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MATERIALS AND METHODS

The enzymatic hydrolysis of the esters was determined by the manometric technic at 37.5° C. (Metcalf and March, 1949, 1950). The enzyme sources were breis prepared by homogenizing insect tissues in a buffer composed of 0.15 *M* NaCl, 0.04 *M* $MgCl_2$, and 0.025 *M* $NaHCO_3$ and centrifuging out the gross tissue particles at 2500 r.p.m. The breis of insect heads could be stored in the refrigerator and used over a period of a week, but other tissue breis were used as soon as possible after preparation.

All the substrates were of the highest degree of purity, and the majority were synthesized in our laboratory. Because of the low solubility of the substituted phenyl esters, the stock solutions were prepared as 0.15 *M* concentrations dissolved in purified dioxane, and were stored in the refrigerator. The final concentration of the esters in the flasks throughout the experiments was 0.01 *M* obtained by adding 0.2-ml. quantities of stock solution to the main part of the flask together with 1.8 ml. of 10% dioxane in buffer and 1.0 ml. brei, which was pipetted in the side arm. The amount of CO_2 produced during hydrolysis was corrected for non-enzymatic hydrolysis and for the ionization of the phenol liberated (Gawron *et al.*, 1953).

The larval and pupal stages of the house flies were obtained from strains raised routinely in this laboratory; thus the age of the individuals used could be established accurately. The ages of the larvae and pupae of the bees could not be determined conveniently.

DISCUSSION OF RESULTS

Characterization of insect esterases. The esterases of human erythrocytes have been conveniently classified by Mounter and Whittaker (1953) on the basis of inhibition by diisopropyl fluorophosphate and by eserine at 1 x 10^{-6} *M* as a) ChE inhibited by phosphate and carbamate; b) AliE inhibited by phosphate but not by carbamate; and c) ArE not inhibited by either phosphate or carbamate. This method was applied to the characterization of insect esterases, with ACh and PhAc as substrates, using fly- and bee-head breis, bee-abdomen and bee-thorax breis, and cockroach nerve-cord brei, inhibited by 1 x 10^{-6} *M* para-oxon and prostigmine. The results are shown in Figure 1, calculated as the percentages of each of the three types of esterase activity present.

It is apparent that the tissues vary considerably in the relative amounts of esterases present and that both ACh and PhAc are hydrolyzed to some degree by each of the three enzymes. Essentially pure nerve tissue such as the roach cord or fly head appeared to contain largely ChE with smaller amounts of AliE. However, ArE was found to be present in large amounts in the bee-abdomen and bee-thorax breis and in smaller amounts in bee-head brei. This enzyme was not appreciably inhibited by para-oxon or prostigmine at concentrations as high as 1 x 10^{-3} *M*, and these tissues have been used as an abundant source of insect ArE.

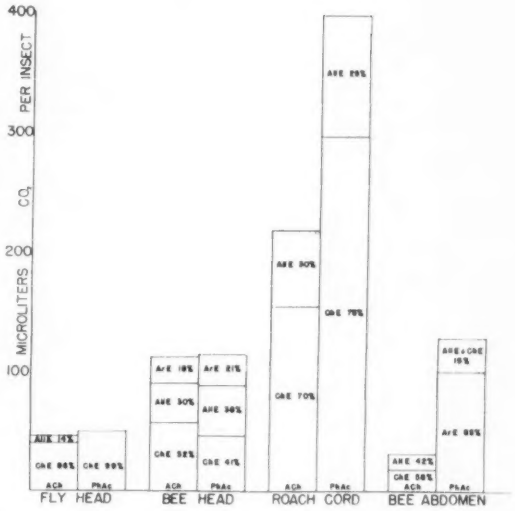

FIG. 1. Percentages of esterases in various insect breis.

For comparison, the rates of hydrolysis of various esters by breis from certain tissues of *Periplaneta americana* (L.) are shown in Figure 2, where the values represent comparative enzymatic activities from equivalent weights of tissue. The activity is much greater in the nerve cord than in any other tissue, and the rate of hydrolysis of PhAc is especially remarkable as it exceeds that of ACh and represents the hydrolysis of 5.6 micromoles of PhAc per mg. of tissue per hour at 37° C.

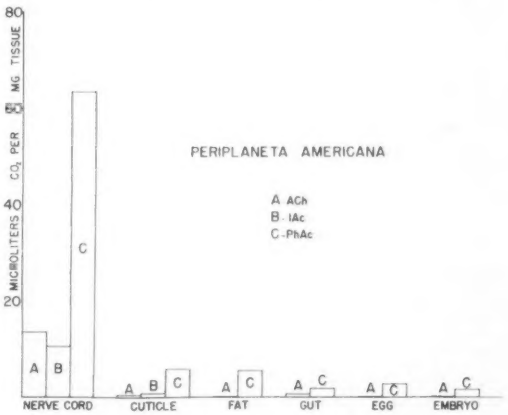

FIG. 2. Relative rates of hydrolysis of various substrates by tissues of *Periplaneta americana*.

However, the experiments with selective inhibition (Figure 1) show that this activity is apparently due not to ArE but to ChE and AliE, thus indicating the necessity for selective inhibition experiments to be carried out along with the variation in substrates to apportion the various enzyme activities present.

It was of interest to compare the rates of hydrolysis of ACh, acetyl β-methylcholine (AMeCh), PhAc, and isoamyl acetate (IAc) by the total breis of the various life stages of the house fly, *Musca domestica* L., and of the honey bee, *Apis mellifera* L. The results obtained are shown in Figure 3. In the house fly the hydrolysis of PhAc is slightly more than twice that of ACh in the egg, larva, and pupal stages, but in the adult the hydrolysis of ACh is higher, perhaps as a result of the development of the central nervous system with its high content of ChE (Metcalf and March, 1950). A similar picture is shown with the bee, but the hydrolysis of PhAc is consistently higher than that of ACh.

Hydrolysis of substituted alkyl phenyl esters. The relative rates of hydrolysis of various aromatic esters by esterases from breis of house-fly and honey-bee heads were compared with those of a honey-bee-abdomen brei which had been pretreated for 30 minutes with 1 x 10^{-6} *M* paraoxon. This treatment has been shown to inhibit ChE activity completely, leaving the ArE activity intact (Metcalf *et al.*, 1955). The relative rates of hydrolysis as presented in Table I will be seen to vary considerably with the tissues involved. With the flyhead brei, hydrolysis was maximal with the aromatic acetates and inappreciable with propionates and butyrates; however, with the bee brei, propionates were hydrolyzed about as rapidly as the acetates, while phenyl butyrats was hydrolyzed at about ⅓ this rate. It ie interesting that with methyl benzoate, in which the carbonyl group of PhAc is reversed, activity was virtually abolished.

Substitution of the aromatic ring of PhAc has been shown to have a marked effect on the hydrolysis rate of the compound by aromatic esterases from wheat germ (Gawron *et al.*, 1953) and from human erythrocytes (Mounter and Whittaker, 1953). With these enzymes, ring substitution in *o*-, *m*-, or *p*-positions generally increased the rate of hydrolysis above the unsubstituted PhAc, and the effect was greatest with the most electronegative substituents. However, the substituted phenyl acetates were less readily hydrolyzed by the insect breis, and no correlation with the electronic properties of the substituents could be developed.

TABLE I[1]

RATE OF HYDROLYSIS OF AROMATIC ESTERS IN 0.01 M CONCENTRATION BY ESTERASES FROM INSECT BREIS

ESTER	RATIO OF HYDROLYSIS ESTER/PHENYL ACETATE		
	House-fly Head	Honey-bee Head	Honey-bee Abdomen Poisoned ($3x10^{-6}$ *M* Para-oxon)
phenyl acetate	1.0 (63 μl CO_2/head)	1.0 (117 μl CO_2/head)	1.0 (136 μlCO_2/bee)
methyl benzoate			0.14
p-chlorophenyl acetate	0	0.73	0.34
m-chlorophenyl acetate	0.05	0.63	0.86
o-chlorophenyl acetate	0.1	0.70	0.84
p-tolyl acetate	1.04	0.58	0.75
m-tolyl acetate	0.82	1.01	0.98
o-tolyl acetate	0.86	0.93	0.68
p-nitrophenyl acetate	0.08	0.66	0.67
m-nitrophenyl acetate	0.04	0.76	0.93
o-nitrophenyl acetate	0.04	0.95	0.70
p-iodophenyl acetate	0.08	0.57	0.60
m-iodophenyl acetate	0.08	0.50	0.71
o-iodophenyl acetate	0.04	0.27	0.45
p-tert-butylphenyl acetate	0	0.42	0.34
m-tert-butylphenyl acetate	0.05	0.38	0.30
o-tert-butylphenyl acetate	0	0.02	0.14
p-cyclohexylphenyl acetate	0.04	0.24	0.35
o-cyclohexylphenyl acetate	0.04	0.38	0.46
m-ethylphenyl acetate	0.10	0.70	0.55
m-dimethylaminophenyl acetate	0.33	0.88	0.77
m-dimethylaminophenyl acetate methiodide	0	0.10	0.20
phenyl propionate	0	1.07	0.64
p-chlorophenyl propionate	0.23	0.90	0.58
m-tert-butylphenyl propionate	0.19		0.26
phenyl butyrate	0.06	0.38	0.33
2-isopropyl-5-methyl isobutyrate	0		0.35
o-tert-butylphenyl isobutyrate	0		0

Separation of cholinesterase and aromatic esterase. A number of methods were tried for the separation of the two enzymes. Fractional precipitation with ammonium sulfate has been employed to purify ChE from electric eel tissue (Rothenberg and Nachmansohn, 1947) and purification of the ArE was attempted by this method. When 52.1 g. of bees were homogenized in 500-ml. Warburg buffer and the concentration of ammonium sulfate was successively raised to 15, 20, 25, 30, 35, and 40%, a precipated fraction of ArE was obtained which was concentrated about 5 times and showed no trace of ChE activity. By starting with bee heads and following the same stepwise increases in ammonium sulfate concentration, both ChE and ArE were precipitated at 40%, and the enzymes were concentrated between 10 and 20 times.

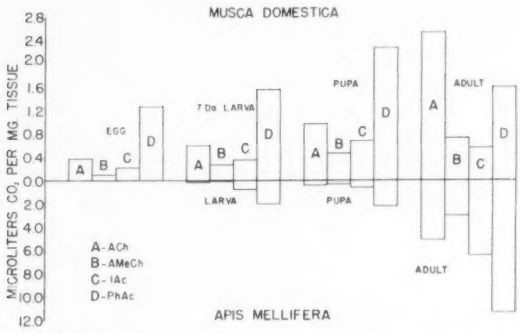

FIG. 3. Relative rates of hydrolysis of various substrates by total breis of stages of *Musca domestica* and *Apis mellifera*.

Alcohol inactivation (Fodor and Greenstein, 1949) was applied to the bee- and fly-head breis by adding ethyl alcohol to the breis for 10 minutes prior to the addition of the substrates. With fly-head brei the rate of hydrolysis of the two substrates was decreased by the following percentages: 3.3% alcohol, ACh 0, PhAc 0; 10% alcohol, ACh 0, PhAc 8; 20% alcohol, ACh 72, PhAc 90. The same experiment repeated with bee-head brei showed marked activation with both substrates at 3.3% and 10% alcohol.

When bee-head breis were left overnight in 15% alcohol and the precipitate collected after 24 hours in the refrigerator, 39% of the ACh activity and 50% of the PhAc activity were precipitated. At 30% alcohol the enzymatic activity in both supernatant and precipitate was largely destroyed.

Heat treatment of fly-head brei at 50° C. for 4.5 hours inhibited 77% of ACh and 62% of PhAc hydrolysis, and at 60° C. for 30 minutes the inhibitions were ACh, 100% and PhAc, 64%.

Smallman and Wolfe (1953) demonstrated that ChE is present in fly homogenates in both a soluble and a particulate state. This was confirmed by using fly-head breis in which 64% of the activity with ACh and 52% of the activity with PhAc as substrates were precipitated by centrifugation at 25000 x G. Centrifuging of whole-bee brei at the same speed precipitated 60% of ACh activity and 27% of the PhAc activity. Comparisons of the activity of normal and poisoned whole-bee breis were made with ACh and PhAc after various speeds of centrifugation as shown in Table II. Twenty-seven percent of the PhAc activity of the normal and 24% of that of the poisoned brei was in the pellet at 25000 x G. Apparently ArE is completely soluble in breis centrifuged at 2040 x G.

Inhibition of aromatic esterase. Aldridge (1953) found that A-esterase of mammalian plasma was strongly inhibited by Cu^{++}, Ni^{++}, and *p*-chloromercuribenzoic acid, and Hobbiger (1954) obtained similar inhibition of the enzyme hydrolyzing diethyl 3-*N*-methylquinoline phosphate metho-

TABLE II

CENTRIFUGAL FRACTIONATION OF WHOLE BEE BREI, USING ACH AND PHAC AS SUBSTRATES

xG	PERCENT OF ACTIVITY REMAINING IN SUPERNATANT			
	Unpoisoned		Poisoned $1x10^{-6}$ *M* para-oxon)	
	ACh	PhAc	ACh	PhAc
0	100	100	0	100
2040	84	98	0	100
8170	44	71	0	85
25000	40	73	0	76

sulfate. Preincubation of the ArE from bee breis (inhibited with para-oxon) for 30 minutes with 1 x 10^{-2} *M* concentrations of copper sulfate, nickel sulfate, potassium cyanide, sodium fluoride, sodium arsenate, and sodium selenite had no inhibitory effects, and the copper sulfate, sodium arsenate, and sodium fluoride actually appeared to activate the enzyme. Similar preincubation with the following compounds at 1 x 10^{-3} *M* had no effect on activity toward PhAc: diethyl phenyl phosphate, *p*-chlorophenyl chloromethyl sulfone, *N*-phenyl methyl carbamate, *N*-methyl phenyl carbamate, *m*-tert-butylphenyl *N*-methyl carbamate, *p*-chlorophenyl methyl sulfone, *p, p'*-DDT, lindane, aldrin, nicotine, rotenone, and pyrethrins.

Fluorescein and eosin have recently been shown to inhibit horseliver esterase (Burch, 1954), and the following percent inhibitions were obtained by 30 minutes preincubation with the ArE at 1 x 10^{-3} *M:* sodium fluoresceinate, 59; benzoic acid, 38; *o*-chlorobenzoic acid, 33; salicylic acid, 34; 5-bromosalicylic acid, 27; acetyl salicylic acid, 7; and *p*-chloromercuribenzoic acid, 9. Methyl ben-

zoate in addition to being inactive as a substrate produced only 23% inhibition at 10^{-2} *M*.

Properties of aromatic esterase. The relation of activity to substrate concentration for bee ArE with PhAc is shown in Figure 4. The limiting value here is the solubility of PhAc, which is about 200 mg./100 ml. or slightly greater than 0.01 *M* at 37° under the conditions employed in the manometric assay. When the values of Figure 4 were plotted as S *vs.* S/V, as described by Lineweaver and Burk (1934), the Michaelis-Menten constant $K_s = 4.36 \times 10^{-3}$ and the theoretical maximum reaction velocity $V_{max} = 139$.

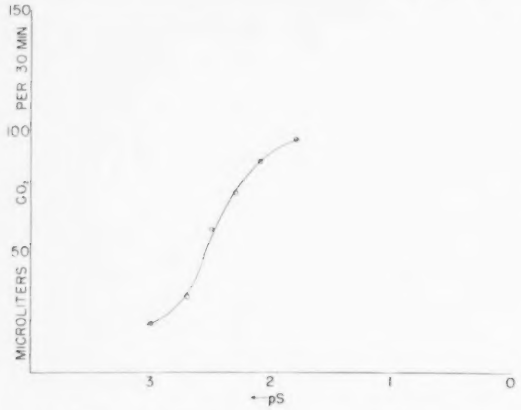

FIG. 4. Substrate-activity curve for hydrolysis of phenyl acetate by ArE from *Apis mellifera*.

Role of aromatic esterase in action of phosphorus insecticides. Recent papers by Lord and Potter (1951) and by Hopf (1952) have suggested that the organic phosphorus toxicants may function by the inhibition of the enzymes hydrolyzing *o*-nitrophenyl acetate. It has already been shown that specific ArE from the bee, fly, and cockroach is not affected by a concentration of para-oxon of more than 1000 times that required for complete inhibition of ChE activity. To further assess the role of these esterases in the mode of action of the organic phosphorus compounds, the effects of 30-minute incubation of 1×10^{-6} *M* para-oxon with breis from bee heads and abdomens were compared, using ACh, IAc and PhAc as substrates. As will be seen in Table III, the phosphorus toxicant inhibited all the enzymatic hydrolysis of ACh and nearly all that of IAc. In the bee-head brei inhibition of the PhAc hydrolysis was 70%, agreeing with our previous estimate that 70–80% of the PhAc hydrolysis in nervous tissue was inhibited by para-oxon. However, in the bee-abdomen brei only 18% of the PhAc hydrolysis was inhibited.

Adults of *Periplaneta americana* were treated topically under the wings with 2γ of para-oxon (about two times the LD_{50}), and after 24 hours when the insects were prostrate the esterase activity to ACh, IAc, and PhAc was measured with breis of head, gut, nerve cord, and cuticle, and compared with normal controls. The results are presented in Table IV and show that ACh hydroysis was completely inhibited in all tissues, but that the hydrolysis of IAc and PhAc was only partially inhibited.

TABLE III

EFFECT OF PRETREATMENT WITH 1×10^{-6} M PARA-OXON ON HYDROLYSIS OF ESTERS BY BEE-HEAD AND ABDOMEN BREI

BREI	μl CO_2 IN 30 MINUTES		
	ACh 0.01 *M*	IAc 0.1 *M*	PhAc 0.01 *M*
Bee-head (normal)	255	314	612
Bee-head (poisoned)	0	0	182
% inhibition	100	100	70
Bee-abdomen (normal)	295	412	568
Bee-abdomen (poisoned)	0	40	465
% inhibition	100	90	18

TABLE IV

INHIBITION OF ESTERASES IN TISSUE BREIS OF PERIPLANETA AMERICANA TOPICALLY TREATED WITH 2γ PARA-OXON

TISSUE AFTER 24 HOURS	μl CO_2/mg. TISSUE		
	Substrate		
	ACh 0.01 *M*	IAc 0.01 *M*	PhAc 0.01 *M*
Head			
Normal	0.49	0.97	7.2
Poisoned	0	0.12	0.58
% inhibition	100	88	88
Gut			
Normal	0.10	1.65	2.08
Poisoned	0	1.02	4.47
% inhibition	100	38	0
Nerve Cord			
Normal	13.5	5.6	63.5
Poisoned	0	2.4	10.3
% inhibition	100	57	84
Cuticle			
Normal	0.46	0.89	5.7
Poisoned	0.10	0.31	0.96
% inhibition	78	65	83

These *in vivo* experiments agree with the *in vitro* data previously presented, showing that the ChE and AliE hydrolyzing ACh are much more sensitive to inhibition by para-oxon than the ArE, and that a portion of the hydrolysis of IAc and PhAc is accomplished by ChE and AliE. The insensitivity of the ArE shows that inhibition of this enzyme is not the site of the toxic action of

the organic phosphorus compounds. In fact, ArE appears to be of importance in the detoxification of the phosphorus insecticides in the insect body.

When aromatic phosphorous esters were used as substrates with the bee-abdomen brei, ready hydrolysis occurred, as shown in Table V. The phosphates were hydrolyzed at rates of about 0.4 to 0.7 that of the corresponding acetates. Summation studies showed that about 14% competitive inhibition occurred when a mixture 0.003 *M* in *p*-nitrophenyl acetate and *O*, *O*-diethyl *O*-*p*-nitrophenyl thionophosphate (parathion) which produced 280 μl CO_2 in 30 minutes, was compared with the sum of the individual values of 325 for *p*-nitrophenyl acetate and 122 for parathion, indicating that the hydrolysis of both substrates is being carried out by the same enzyme.

The thionophosphate parathion appeared to be somewhat more rapidly hydrolyzed than the phosphate para-oxon, an opposite trend to the relative rates of alkaline hydrolysis (Metcalf and March, 1953).

TABLE V

HYDROLYSIS OF 0.01 M PHENYL PHOSPHATES BY BEE-ABDOMEN BREI

	μl CO_2 in 30 MINUTES
O, *O*-diethyl phenyl phosphate	54
O, *O*-diethyl *p*-tolyl phosphate	80
O, *O*-diethyl *p*-chlorophenyl phosphate	11
O, *O*-diethyl *p*-nitrophenyl phosphate	40
O, *O*-diethyl *p*-nitrophenyl thionophosphate	85

SUMMARY

Experiments with the selective inhibitors paraoxon and prostigmine have shown that tissues of *Apis mellifera*, *Musca domestica*, and *Periplaneta americana* contain at least three types of esterases, a specific cholinesterase (ChE) an aliphatic esterase (AliE) and an aromatic esterase (ArE). Central nervous system tissues contain largely ChE with some AliE, while ArE which is not inhibited by either para-oxon or prostigmine is found in large amounts in the body tissues of the honey bee and the cockroach. The ArE hydrolyzed phenyl acetate at a rate greater than any other substituted phenyl acetates, and phenyl propionate and butyrate were hydrolyzed at lower rates, while methyl benzoate was only slowly hydrolyzed. The ArE and ChE could be partially separated by several means, such as by alcohol inhibition and heat treatment, while differential centrifugation of whole-bee breis indicated that the ChE activity was largely particulate and the ArE activity was largely soluble at 2040 x G.

The ArE was not inhibited by a large variety of heavy metal salts, carbamates, phosphates, and insecticides, but showed slight inhibition by fluorescein, and by benzoic acid at 1 x 10^{-3} *M*. This enzyme hydrolyzed a number of phosphorous esters such as para-oxon and parathion and appears to provide a detoxification mechanism for these toxicants.

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TETRALICIA AND A NEW RELATED GENUS, ALEUROPLEUROCELUS (HOMOPTERA: ALEYRODIDAE) [1]

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Until recently no new species related to *Aleyrodes nigrans* Bemis had been described from California. It and related forms previously have been included in the genus *Tetralicia*. While studying California aleyrodids the writers have come to the conclusion that this group of species represents a genus distinct from *Tetralicia*. This idea has been strengthened as a result of correspondence with Mr. F. Laing, of the British Museum (Natural History), who therein indicated some of the salient differences between *T. ericae* Harrison and the three known and one new California species.

The genus *Aleuropleurocelus* is, therefore, being erected to receive the California species previously included in *Tetralicia* and a new species which is being designated as the genotype.

Since these two genera, *Tetralicia* and *Aleuropleurocelus*, differ significantly from other members of the tribe Aleyrodinae, a generalized drawing and a glossary of terms are included in order to point out more clearly the recognition characters. In general, these characters will help one in recognizing those of other genera.

GLOSSARY OF TERMS USED

Most of the following characters defined below are also illustrated in Figure 1A.

Apparent Margin. The outermost visible margin of the body as seen from above. It is not the true margin.

Dorsal Abdominal Ridge. A ridge of varying width and elevation running along the median line of the abdomen.

Dorsal Disc. All the dorsal area surrounded by the true margin.

Eighth Dorsal Abdominal Setae. A pair of small setae located on the eighth abdominal segment. This segment is anterior and lateral to the vasiform orifice.

Marginal Band. This area is peculiar to the two genera, *Tetralicia* and *Aleuropleurocelus*, being discussed in this paper. It consists of a band bordering the outer margin of the dorsal disc. Approximately half of this band is readily visible and the other half is partially deflexed and not readily visible when viewed from above. The apparent margin constitutes the approximate mid-point of the band.

Median Abdominal Depressions. Small invaginations on or just behind the abdominal sutures. May be made prominent by varying degrees of surrounding sclerotization.

Median Area. All the dorsal area surrounded by the marginal band.

Molting Suture. Actually this is an emergence suture for the adult when it emerges from the pupal case. It is also referred to as the inverted T-shaped slit or lines of the cephalothorax. It consists of two portions:

a. The transverse suture extending across the body at the juncture of the thorax and abdomen.

b. The median suture extending from the middle of the transverse suture cephalad to the body margin.

Porettes. Very minute pores. Usually considered too small to be called pores. The porettes and setae are designated according to their location.

Posterior Protuberance. A projection of the abdomen situated on the posterior end of the body directly behind the vasiform orifice. It normally bears a pair of setae.

Setae. Slender, more or less rigid, bristle-like short hairs. The three general types used here, from shortest to longest, have been designated respectively as minute setae, small setae, and setae.

Submedian. A term applied to an area of varying width lying on each side of the median line. Usually considered to extend out to the ends of the abdominal sutures.

True Margin. In the genera *Tetralicia* and *Aleuropleurocelus* the true margin of the body comes in contact with the leaf upon which the pupal case may be situated. Usually is identifiable by having a border row of teeth. Forms the line between the venter and dorsal disc. This margin is distinguished from the apparent margin.

Vasiform Orifice Ring. A sclerotized band of varying width surrounding the vasiform orifice.

The two genera being considered in this paper fall into the tribe Aleyrodini. The genus *Tetralicia* is included in the key to California genera of the Tribe Aleyrodini in order to show how it can be separated from the genus *Aleuropleurocelus* and the other California genera included in this tribe.

[1]Accepted for publication, June 14, 1955.

KEY TO GENERA OF CALIFORNIA ALEYRODINI
(Pupal cases)

1. Sides of case deflexed to meet shortened ventral disc 2
—. Sides of case not deflexed to meet shortened disc ... 3
2. Inner margin of vasiform orifice with teeth, operculum filling not over three-fourths of orifice ..... *Tetralicia*
—. Inner margin of orifice smooth, operculum filling or nearly filling orifice ..... *Aleuropleurocelus*
3. Dorsal disc separated from submarginal area by a line or fold ..... *Tetraleurodes*
—. Dorsal disc not separated from submarginal area .. 4
4. Margin smooth or slightly irregular, not regularly toothed ..... *Aleyrodes*
—. Margin regularly toothed 5
5. Margin with one row of teeth ..... *Aleurotulus*
—. Margin with two rows of teeth ..... *Aleurothrixus*

THE GENUS **TETRALICIA**

The genus *Tetralicia* was erected by Harrison (1917a, 1917b) for the new species, *Tetralicia ericae* Harrison. Subsequently the California species, *Aleyrodes nigrans* Bemis, was transferred (Baker, 1937) to *Tetralicia*, and *T. ceanothi* Sampson and *T. sierrae* Sampson were described in it. The present study reveals that the California species are distinct from those in *Tetralicia*. Therefore *Tetralicia* should now include only *Tetralicia ericae* which is known only from England.

Since topotypic specimens of *Tetralicia ericae* were not available for this study, the type locality's having been used for military purposes with destruction of all host plants, it was necessary to obtain information regarding the genus in another manner. The necessary information was obtained from Mr. F. Laing of the British Museum, who furnished a drawing of the pupal case and added his observations and opinions in the correspondence. Additional drawings and information were obtained from the work of Trehan (1940). It is upon Harrison's original description and information from Laing and Trehan that this study has been based.

Genus **Tetralicia** Harrison

Tetralicia Harrison, 1917a, Vasculum, 3: 60.
Tetralicia Harrison, 1917b, Entomoligist, 50(651) : 170.
Tetralicia Harrison, Sampson, 1943, Ent. Amer., 23 (n.s.) (3) : 216.
Tetralicia Harrison, Sampson and Drews, 1941, An. Esc. Nac. Cien. Biol., 2(2 & 3) : 169.

Pupal case. Elliptical in form; true margin only slightly irregular; circular papilla-like structures present on area of dorsal ridge; median posterior deflection of the transverse molting suture reaching the distal portion of the first abdominal suture; vasiform orifice surrounded by sclerotized ring; orifice sub-circular in shape; inner posterior portion of orifice margin with broad blunt teeth; operculum subcordate, not filling more than three-fourths of orifice area; lingula hidden by operculum; outer portion of marginal band deflexed; posterior protuberance present.

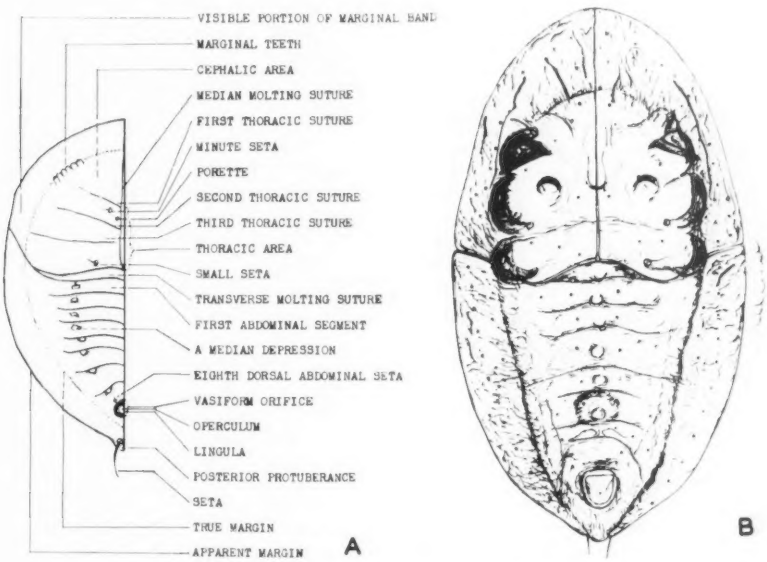

FIG. 1. A. Generalized drawing showing aleyrodid characters mentioned. B. Pupal case of *Tetralicia ericae* Harrison (illustration furnished by F. Laing).

Tetralicia ericae Harrison

(Figure 1B, 2C)

Tetralicia ericae Harrison, 1917a, Vasculum, 3: 60.
Tetralicia ericae Harrison, 1917b, Entomologist, 50: 170.
Tetralicia ericae Harrison, Trehan, 1940, Trans. Roy. Ent. Soc. London, 90: 606–607.

Pupal case. Size: 1.030 mm. long by 0.560 mm. wide. Shape: narrowly elliptical. Margin apparently only slightly irregular. Cephalic area not visibly separated from first and second thoracic segments; setae not present; two pairs of small pores near median molting suture; eyespots not observed. Thoracic area with setae apparently lacking; one pair of small pores present on first thoracic segment; second thoracic segment with two or three pairs of small pores. First and second thoracic sutures not visibly developed; third thoracic suture moderately developed, terminal portion reaching marginal band. Transverse molting suture reaching apparent margin. Abdominal area without setae; two small pores on first abdominal segment, one pair of small pores on second, third, fourth, and fifth abdominal segments, two pairs on sixth abdominal segments; eighth dorsal abdominal setae minute. Dorsal abdominal sutures poorly developed; median depressions absent; dorsal abdominal ridge poorly developed, with circular papilla-like structures on first six segments; vasiform orifice surrounded by a moderately broad, subcircular, sclerotized ring; vasiform orifice 0.06 mm. long by 0.05 mm. wide, subcircular in form; operculum subcordate, filling about three-fourths of orifice, obscuring lingula. Posterior protuberance moderately developed, bearing two setae 0.045 mm. long. Distance from posterior edge of vasiform orifice to visible margin of protuberance 0.060 mm. Marginal band with visible portion of area smooth or only slightly rugose, and bearing a single ring of small pores; a second row of approximately five pores occurs near the inner edge of the marginal band between the fourth abdominal suture and the second thoracic suture. Deflexed portion of the marginal band about one-fourth width of case at line of third thoracic suture, slightly wider in cephalic area.

Pupal case in situ. Although Harrison described the color of the larva as transparent but whitish, Trehan gives the color as dark in one reference and black in another.

Host. Erica tetralix L.

Type locality. Waldridge Fell, in North Durham, July, 1916.

Previously recorded distribution. Trehan (1940) collected this species on *Erica tetralix* L. from Hindhead, Surrey, and Wheathampstead, Herts.

Biology. Harrison (1917b) gives the following information concerning the immature forms of *Tetralicia ericae.* "Pupal case with practically no waxy secretion. Both larva and pupa are extremely elongated. Larva—necessarily elongated to enable it to feed between the in-rolled margin and midrib of a leaf of a member of the genus *Erica.* Color, transparent but whitish. Pupa—likewise elongated and for similar reasons. The insect is continuously brooded."

THE GENUS **ALEUROPLEUROCELUS**

Aleuropleurocelus new genus

Pupal case. Elliptical to broadly ovate in form; apparent margin only slightly irregular; true margin with teeth; dorsal ridge without papilla-like structures; median posterior deflection of transverse molting suture not reaching distal portion of first abdominal suture; vasiform orifice devoid of teeth; orifice surrounded by a sclerotized ring; operculum cordate or subcordate in form, almost or completely filling orifice; lingula hidden by operculum; outer portion of marginal band deflexed; posterior protuberance usually present.

Type. Aleuropleurocelus laingi, new species.

The two genera differ in that *Tetralicia* possesses the following characters which are not found in *Aleuropleurocelus:* Teeth in the vasiform orifice, papilla-like structures on the dorsal ridge, true margin apparently smooth or only slightly irregular, transverse molting suture not reaching the distal portion of first abdominal suture, vasiform orifice subcircular, and operculum shorter and smaller.

The genera are similar in that both have the deflexed portion of the marginal band, a sclerotized ring surrounding the vasiform orifice, and the lingula hidden by the operculum.

Trehan (1940) described the pupal case of *Tetralicia* as dark or black. This is also true of the species of *Aleuropleurocelus.* It will be noted that Harrison (1917b) stated the color was transparent and whitish. Possibly he was dealing with immature forms or again his observation may have been inaccurate.

Morphological characters indicate that despite their wide geographic separation *Tetralicia* and *Aleuropleurocelus* are more closely related to each other than they are to other genera in the subfamily Aleyrodinae.

Aleuropleurocelus laingi new species

(Figures 2A, 2B)

Pupal case. Size: 0.750 mm. long by 0.450 mm. wide. Shape: elliptical. Margin toothed; teeth comparatively square in shape; an average of 12 teeth in 0.1 mm. Cepalic area not visibly separated from first thoracic segment; setae not present; one pair of porettes on posterior portion; eyespots not evident. Thoracic area with first segment having no setae or pores; second thoracic segment has one minute setae and two porettes; third segment with one or two porettes located anterolaterally from setae. Second thoracic

suture lightly indicated by a line not quite reaching outer edge of median area. Third thoracic suture well indicated and reaching to edge of median area. Terminal end of transverse molting suture extending anteriorly almost to line of second thoracic suture and curving laterally to reach apparent margin. Abdominal area with no evidence of setae; one pair of porettes on outer portion of first, third, fifth and seventh dorsal abdominal segments; dorsal abdominal ridge poorly developed. Vasiform orifice surrounded by a narrow slightly sclerotized ring subcordate in form, anterior edge almost straight; orifice 0.039 mm. in length and 0.039 mm. in width, subcordate in form; operculum subcordate in shape, filling orifice, obscuring lingula. Posterior protuberance moderately well developed, bearing a pair of setae 0.031 mm. long. Distance from posterior edge of vasiform orifice to visible margin of protuberance 0.040 mm. Marginal band with an irregular row of porettes extending along each side of inner part of visible portion, without about one porette opposite each abdominal suture, an equal number in cephalothoracic area, making a total of approximately 32 porettes. Deflexed portion of marginal band about one-fifth width of case in all areas, except around vasiform orifice region.

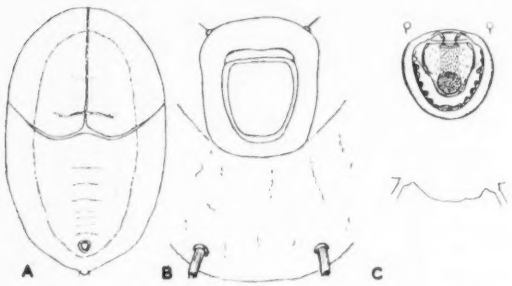

FIG. 2. A. Pupal case of *Aleuropleurocelus laingi* new species. B. Vasiform orifice of *A. laingi* n. sp. C. Vasiform orifice of *Tetralicia ericae* Harrison (From Trehan 1940).

Pupal case in situ. Dorsum shiny black, with wax; a band of striated shiny wax, having the appearance of very closely united wax rods, extending out beyond the apparent margin about the width of the visible marginal band. Apparent margin slightly dentate. Abdominal sutures noticeable.

Host. Arctostaphylos sp. and *Salvia apiana* Jepson var. *compacta* Munz.

Type locality and types. Trabuco Canyon, Orange County, California. Collected on October 30, 1953, by E. A. Drews. Described from 132 specimens mounted on 18 slides. Holotype and paratypes (pupal cases) in the collection of the authors.

Taxonomy. In general shape and appearance *A. laingi* resembles *A. ceanothi* (Sampson) and *A. sierrae* (Sampson). It can be separated from these species by the irregular row of porettes extending along each side of the inner part of the visible portion of the marginal band.

The specimens from Mill Creek Canyon, San Bernardino County, California, on *Arctostaphylos* sp., were distinctly larger than the typical specimens. They also presented some differences in details of the vasiform orifice. Otherwise they are not dissimilar.

This species is named in honor of Mr. F. Laing, now retired from the British Museum (Natural History), in gratitude for his help and numerous suggestions regarding this complex of aleyrodids.

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See the December, 1955, Bulletin of the Entomological Society of America for revised schedule of prices for reprints of papers accepted for publication after January 1, 1956.

REVISION OF THE NORTH AMERICAN CALYCOMYZA SPECIES NORTH OF MEXICO (PHYTOBIA: AGROMYZIDAE: DIPTERA)[1,2]

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The subgenus *Calycomyza* is one of ten that has been identified within the large and diverse genus *Phytobia* Lioy (= *Dizygomyza* Hendel, 1931) (Hendel, 1931; Frick, 1953). Although the species referred to *Calycomyza* have been studied or revised a number of times (Melander, 1913; Malloch, 1913, 1918; Frost, 1924; Hering, 1951; Frick, 1952) confusion as to the exact identity of some of the species, particularly *jucunda* van der Wulp, 1867, has existed throughout the years. In my catalogue of New World species (Frick, 1952) I was fortunate in choosing the right species for the name *jucunda*. Since that time the holotype of *platyptera* Thomson, 1868, has been examined. Specimens compared with it were sent to Dr. Diakonoff at Leiden to compare with the holotype of *jucunda*. He found that my specimens were the same as van der Wulp's type and returned them labelled as homotypes of *jucunda*.

The North American species included in *Calycomyza* are characterized by being robust, shining or dull black with yellow frontal vitta and notopleural triangle, legs black except sometimes fore-legs with "knees" narrowly yellow, abdomen usually all black, sometimes with tergites narrowly yellow posteriorly; head with lunule low, semicircular, antennal bases approximate, gena not more than one-third the eye height; prescutellar setae absent or not differentiated, one intraalar seta, usually three, rarely four, pairs of dorsocentral setae posterior to mesothoracic transverse suture, rarely one to three presutural dorsocentrals (*majuscula* and *gigantea*); wing with m-m or posterior crossvein present, seldom more than its own length from r-m crossvein, apex of vein M_{1+2} nearest wing tip, and of moderate size (1.25 to 3.25 mm. in wing length).

DISTRIBUTION

Seven new species are described herein, bringing the number of known species found north of Mexico to 14 and the number of known species in the World to 20 (Table I). One more, *Agromyza frontella* Malloch, 1914, on the basis of its description, appears to belong to this subgenus and is questionably included in the table. Only Europe and the United States have been adequately collected for these small flies. The Nearctic Region may be the center of speciation, as only five species are known from Europe, in spite of the many years of intensive collecting. Those species having the margin and fringe of the calypter brown or black seem in particular, to be American; in Europe three such species are known while nine are included in this paper, five as new.

BIOLOGY

Of the 21 species included in the table, the adults of all but four have been reared from larvae mining in leaves of plants. The mines that are known take the form of a blotch, linear-blotch, or an extremely twisted linear that becomes a blotch (figs. 7–13).

The larvae have small knob-like anterior spiracles that bear from five to 15 spiracular bulbs each. The posterior spiracles usually have three spiracular bulbs each, but may have up to 10 (figs. 3–5). The larvae may show greater differences than the adults. For example, the adults of *jucunda* and *promissa* are very similar and can be separated only by slight and sometimes overlapping differences. However, the larvae of these two species are quite different (figs. 5 and 6).

The larvae of six species (*artemisiae, flavinotum, gyrans, majuscula, malvae, allecta*) are known to leave the mines to pupate while five (*humeralis, jucunda, promissa, solidaginis, verbenae*) remain in the mines. The larvae that pupate in the mines attach the puparium to the lower epidermis with a mass of frass. Before pupating, the larva cuts a curved slit in the upper epidermis through which the adult can escape (figs. 7–13). The frass is deposited in different patterns, but is usually most concentrated at the site of pupation or exit.

ADULT CHARACTERS

Adults of most of the species are very similar in appearance. *P. gyrans* and *semigyrans* are atypical in lacking the characteristic bright yellow markings on head and thorax. *P. meridiana* (= *meridionalis* of Malloch, 1914) is unique in having the third antennal segment yellow. Although the femora are black in most species, some have the fore-femora very narrowly yellow distally. The remaining species are black with yellow head and body markings.

A study of the key will reveal how frequently color, particularly of the genovertical plates, is

[1]Scientific Paper No. 1401, Washington Agricultural Experiment Stations, Pullman. Project No. 1260. Accepted for publication, April 1, 1955.
[2]This investigation was supported in part by a grant-in-aid from the National Science Foundation.

TABLE I

LIST OF *Calycomyza* SPECIES FOUND THROUGHOUT THE WORLD WITH LARVAL HOST PLANT RECORDS

SPECIES	ZOOGEOGRAPHICAL REGION	LARVAL HOST PLANTS	
		FAMILY	SPECIES
allecta	Nearctic	Compositae	*Bidens frondosa* L., *Helianthus*
Melander, 1913	Neotropical		sp., *Rudbeckia* sp.
		Euphorbiaceae[a]	*Sauvia* sp.
ambrosiae	Nearctic	Compositae	*Ambrosia artemisiifolia* L., *A. trifida* L.
n. sp.			
artemisiae	Holarctic	Compositae	*Artemisia douglasiana* Bess., *A. vul-*
Kaltenbach, 1856	Neotropical		*garis*, L., *Rudbeckia*, cultivated var.
	? Australian		In Europe: *Artemisia absinthium*
			L., *A. cannabinum* L. In Japan:
			Artemisia absinthium L.
cassiae	Neotropical	Leguminosae	*Cassia bacillaris* L.
Frost, 1936			
cynoglossi	Nearctic	Boraginaceae	*Cynoglossum* sp.
n. sp.			
flavinotum	Nearctic	Compositae	*Arctium lappa* L., *Eupatorium*
n. sp.			*purpureum*
		Caprifoliaceae	*Viburnum pubescens*
? *frontella*	Oriental	Unknown	Unknown
Malloch, 1914			
gigantea n. sp.	Nearctic	Unknown	Unknown
gyrans	Palaearctic	Campanulaceae	*Adenophora*, 4 sp., *Campanula*, 32 sp.,
Fallén, 1823			*Codonopsis silvestris*, Kom., *Phy-*
			teuma, 8 sp., *Symphyandra hoff-*
			mannii Pant.
humeralis	Holarctic	Scrophulariaceae	*Pentstemon procerus* Dougl.
von Roser, 1840	Ethiopian	Compositae	*Aster chilensis* Nees., *Aster*, culti-
			vated vars., *Baccharis douglasii* D.
			C., *Erigeron canadensis* L., *Helian-*
			thus annuus L., *Heterotheca grandi-*
			flora Nutt., *Madia elegans* Don.,
			Solidago macrophylla, *Zinnia*, cul-
			tivated var. In Europe: *Aster*
			amellus L., *A. bellidiastrum* L.,
			Bellis, 4 sp., *Bellium bellidioides* L.,
			Calistephus sinensis L., *Dichro-*
			cephala latifolia D.C., *Erigeron*, 6
			sp., *Haplopappus cuneifolius* Nutt.
			In Africa: *Erigeron* sp.
ipomaeae	Neotropical	Convulvulaceae	*Ipomoea batatas* Poir.
Frost, 1931			
jucunda van der Wulp,			
1867	Nearctic	Compositae	*Ambrosia trifida* L., *Arctium sp.*,
			Artemisia douglasiana Bess., *A.*
			vulgaris L., *Baccharis viminea* D.C.,
			Erigeron canadensis L., *E.* sp.,
			Globe artichoke, *Grindelia squar-*
			rosa (Pursh.), *Helianthus annuus*
			L., *Heterotheca grandiflora* Nutt.,
			Solidago sp., *Xanthium* sp., *Zin-*
			nia sp.
jucundacea	Neotropical	Papaveraceae	*Papaver rhoeas* L.
Blanchard, 1954		Malvaceae	*Gossypium* sp.
lantanae	Neotropical	Verbenaceae	*Lantana camara*, L. sp.,
n. sp.			*Lippia helleri* Britt.
majuscula	Nearctic	Compositae	*Senecio lugens* var.
n. sp.			*exaltatus* Gray
malvae	Nearctic	Malvaceae	*Abutilon theophrasti* Medic., *Althaea*
Burgess, 1880	Neotropical		sp., *Malva rotundifolia* L., *Malva-*
			strum coromandelianum L., *Sida*
			spinosa L.
meridiana	Neotropical	Unknown	Unknown
Hendel, 1923			
promissa	Nearctic	Compositae	*Aster chilensis* Nees.
n. sp.			
semigyrans	Palaearctic	Unknown	Unknown
Rydén, 1954			
solidaginis	Holarctic	Compositae	*Solidago* sp. In Europe:
Kaltenbach, 1869			*Solidago virga-aurea* L.
verbenae	Nearctic	Verbenaceae	*Verbena neomexicana*, *V.*
Hering, 1951			*wrightii*, and *V. hybrida*, cultivated
			vars.

[a]The specimens from this host are not the same as those of *cassiae* but are very similar to, if not the same as, typical *allecta*.

used in separating species. So many characters that appear valid in individual or a few specimens overlap with other species when a series of 10 or 20 specimens is examined. The descriptions are brief as few more than the separating characters have been included. The measurements used for a character are either the average (for previously described species) or for the holotype (for new species). The extremes are given in parentheses and include both sexes, except for size.

Some of the characters used in the descriptions may need clarification. With the head in profile or lateral view, the eye measurements are taken at the highest and longest distances. The genal height (ventral margin of the eye to the subcranial margin) is measured midway between the vibrissal angle and the back of the head. From the front view of the head the frontal vitta is measured from the ocellar triangle to the top of the lunule (height) and between the two rows of frontoorbital setae (width). There are usually four frontoorbital (or orbital) setae on each of the genovertical plates (orbits). Beginning at the vertex, there are two upper-frontoorbitals, the dorsal and ventral, and below them at least two lower-frontoorbitals, the dorsal and ventral. On the mesonotum, the rows of acrostichal setae are counted at an imaginary line between the second pair of dorsocentrals. The first (anterior or presutural) dorsocentral is usually absent or undifferentiated from the acrostichals. The second (first postsutural) is about one-half as long as the strong third. The fourth is very long and strong. In the wing, cell 1–M_2 (discal) is bordered anteriorly by M_{1+2}. Cross vein r-m joins M_{1+2} somewhere near the middle of the length of the cell. The measurements given in the descriptions are for the ratio of the distance from the basal end of the cell to r-m to the distance of r-m from the distal end (closed by cross vein m-m). Therefore, a number greater than 1.0 means that r-m is distad of the center of the cell. Cross vein m-m varies in its distance from r-m. The measurements are the ratio of the distance m-m is from r-m (the penultimate section of M_{1+2}) to the length of m-m. Here a number greater than 1.0 means that m-m is more than its own length from r-m.

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I am deeply indebted to C. W. Sabrosky for locating the type specimens of *jucunda* and *platyptera*; to H. Oldroyd, British Museum (Natural History), London, for sending four specimens from Williston's syntype series of *allecta;* to René Malaise, Naturhistoriska Riksmuseum, Stockholm, for lending me the holotype of *platyptera*; to A. Diakonoff, Rijksmuseum van Natuurlijke Historie, Leiden, for comparing specimens with the holotype of *jucunda;* to S. W. Frost and A. L. Melander for the opportunity to study their personal collections; to M. T. James for reviewing the manuscript. I wish to thank the following for lending specimens: C. W. Sabrosky and R. H. Foote, United States National Museum; G. E. Shewell, Canadian National Collection; R. T. Mitchell, United States Fish and Wildlife Service; E. S. Ross and E. L. Kessel, California Academy of Sciences; P. D. Hurd, J. N. Belkin, and W. H. Lange, Jr., University of California; H. H. Ross, Illinois Natural History Survey; S. W. Frost, Pennsylvania State University; G. P. Wene, Texas Agricultural Experiment Station; R. H. Jones, University of Wisconsin; V. D. Roth, formerly with Oregon State College; P. J. Darlington, Jr., Museum of Comparative Zoology; J. L. Laffoon and W. L. Downes, Iowa State College; R. E. Beer, University of Kansas; E. M. Hering for identified specimens from Europe.

KEY TO NORTH AMERICAN ADULTS FOUND NORTH OF MEXICO

1. Margin and fringe of calypter white or yellow.... 2
   Margin and fringe dark brown or black..... 6
2. Third antennal segment rounded, subcircular (fig. 1a); anterior half of mesonotum with about six rows of acrostichal setae..... 3
   Third antennal segment with an anterodorsal angle, flattened dorsally beyond base of arista (Fig. 1b); about five rows of acrostichals..... 5
3. Genovertical plates dark from vertex to at least the dorsal upperorbital seta; fore-femora entirely black..... 4
   Genovertical plates dark not more than halfway between inner vertical seta and dorsal upperorbital; fore-femora distally narrowly yellow—1. ..... **lantanae**
4. Second dorsocentral seta more than one-half the length of the third dorsocentral; genovertical plates dark from vertex to at least halfway between the two upper-orbital setae....2. **promissa**
   Second dorsocentral one-half or less the length of the third; genovertical plates dark usually to dorsal, upper-orbital, sometimes beyond, rarely to ventral upper-orbital.....3. **jucunda**
5. Mesofacial plate dark except for narrow yellow epistomal margin; margin and fringe of calypter white.....4. **humeralis**
   Mesofacial plate yellow; margin and fringe yellow.....5. **solidaginis**
6. Mesofacial plate at least one-half dark..... 7
   Mesofacial plate yellow, not more than antennal bases dark.....10
7. Genovertical plates dark from vertex to at least ventral upper-orbital..... 8
   Genovertical plates dark from vertex to dorsal upper-orbital.....6. **artemisiae**
8. Genovertical plates dark, at least narrowly, from vertex to the ventral lower-orbital; second dorsocentral more than one-half the length of the third dorsocentral..... 9
   Genovertical plates dark to ventral upper-orbital or dorsal lower-orbital; second dorsocentral less than one-half the third.....7. **cynoglossi**
9. Mesonotum shining; six rows of acrostichals; humeral seta on black.....8. **majuscula**
   Mesonotum dull, pollinose, four or five rows of acrostichals; humeral seta on yellow...9. **gigantea**
10. Genovertical plates yellow, rarely dark from vertex to halfway to dorsal upper-orbital; third antennal segment ovoid, longer than wide (fig. 1c).....11

Genovertical plates dark at least to dorsal upper-orbital; third antennal segment subcircular (fig. 1a) 12

11. Inner postalar seta on yellow of mesonotum. ..... 10. **flavinotum**
Inner postalar on black of mesonotum. 11. **allecta**

12. Genovertical plates dark from vertex to dorsal upper-orbital 13
Genovertical plates dark at least to ventral upper-orbital ..... 12. **malvae**

13. Frontal vitta relatively wide, not more than 1.4 times as high as wide ..... 13. **ambrosiae**
Frontal vitta relatively narrow, not less than 1.7 times as high as wide ..... 14. **verbenae**

SYSTEMATIC TREATMENT

1. **Phytobia (Calycomyza) lantanae,** new species

Male: Head (profile): eye 1.6 (1.4–1.7) times as high as long; gena 0.17 (0.13–0.20) the eye height; genovertical plates not extending anteriorly of eyes; third antennal segment rounded. Head (front view): genovertical plates not dark, black of vertex extending from interior vertical seta to eye margin near, but not reaching, dorsal upper-orbital; 2 (rarely 3 on one side) lower-orbitals on either side; mesofacial plate yellow. Mesonotum: shining; humeral seta on black (or yellow), 7 (5–9) humeral setulae; 6 irregular rows of acrostichals between the dorsocentral rows; second dorsocentral seta 0.4 (0.25–0.40) the length of the third; inner postalar 0.4 (0.3–0.5) the length of the outer. Legs: fore-femora distally yellow for a distance about equal to femoral diameter; mid-tibiae each with 2 postero-lateral spurs. Wings: margin and fringe of calypter white; r-m cross vein distal to, 1.4: 1 (1.3–1.8), center of cell 1-M_2; m-m cross vein less than, 0.8: 1 (0.7–1.0), its own length from r-m, perpendicular (sometimes at a slight angle) to the penultimate section of M_{1+2}; ultimate section of M_{3+4} 2 (2–3) times as long as penultimate. Size: 1.5 (♂ = 1.25–1.75; ♀ = 1.5–2.0) mm. in wing length.

Female: Very similar to male; second dorsocentral 0.3 the length of the third; r-m cross vein distal to (1.7: 1) center of cell 1-M_2; m-m cross vein less than (0.7: 1) its length from r-m, at a slight angle to penultimate section of M_{1+2}; ultimate section of M_{3+4} 3 times the penultimate; size, 1.6 mm. in wing length.

Holotype ♂.—Weslaco, Texas, III-30-1954 (G. P. Wene), reared from a larva mining a leaf of *Lantana* sp., deposited in the United States National Museum, Washington, D. C. *Allotype* ♀.—Topotypical, same data as holotype. *Paratypes.*—1♂, Alice, Texas, VI-1939 (S. G. Kelley), ex *Lantana*; 1♀, Premont, Texas, VI-1939 (S. G. Kelley) ex *Lantana*; 1♂, 3♀♀, Tampico, Mexico, XI-1954 (N. L. H. Krauss), ex *Lantana camara*; 1♀, San Blas, Mexico, VII-1953 (N. L. H. Krauss), ex leaves of *Lantana camara;* 2♂♂, 1♀, Rio Piedras, Puerto Rico, 1933 (F. Sein), ex leaves of *Lippia helleri* Britt.; 1♂, 1♀, northwest Trinidad, V-1953 (N. L. H. Krauss), ex blotch leaf mines on *Lantana camara*; 4♀♀, St. Augustine, Trinidad, I-1954 (N. L. H. Krauss), ex blotch on *Lantana camara*.

One female from Williston's syntype series af *allecta* in the British Museum belongs to this species. It is from Mount Gay Est. (leeward side), Grenada, West Indies. *P. lantanae* is Neotropical in distribution and it is found along the Gulf Coast into tropical Texas. Alice, Texas, is about 120 miles north of the Mexican border.

P. lantanae may be distinguished from other species in the group with light-colored calypters by having the genovertical plates yellow, the dark from the vertex not reaching the dorsal upper-orbital, and in having the forefemora distally yellow for a length about equal to the femoral diameter.

Puparia included in the San Blas and St. Augustine collections bear three bulbs on each posterior spiracle. The ventral bulb is about twice as long as the dorsal or the laterally-directed bulb.

2. **Phytobia (Calycomyza) promissa,**[3] new species

Phytobia (Calycomyza) jucunda (van der Wulp), Frick *p. p.*, 1952, Univ. Calif. Publ. Ent., 8: 395.

Male: Head (profile): eye 1.4 (1.3–1.4) times as high as long; gena 0.15 (0.15–0.25) of the eye height; genovertical plates slightly extending anteriorly of eyes dorsad of antennae; third antennal segment round (fig. 1a). Head (front view): genovertical plates dark to midway between dorsal and ventral upper-orbital setae, to ventral upper-orbital, or sometimes extending narrowly to dorsal lower-orbital; mesofacial plate ventrally about one-half yellow, black on dorsal half, extending laterally to eyes. Mesonotum: subshining; humeral seta on black, 5 (5–8) humeral setulae; 6 irregular rows of acrostichals between the dorsocentral rows, second dorsocentral 0.7 (0.55–0.8) the length of the third; inner postalar 0.5 (0.5–0.8) the length of the outer. Legs: mid-tibiae each with 1 posterolateral spur. Wings: margin and fringe of calypter white; r-m cross vein near center, 1.2: 1 (1.0–1.3), of cell 1-M_2; m-m cross vein less than, 0.7: 1 (0.6–1.3), its own length from r-m, perpendicular (or at a slight angle) to penultimate section of M_{1+2}; ultimate section of M_{3+4} 2.5 (2.0–2.6) times as long as penultimate. Size: 1.75 (♂ = 1.75; ♀ = 1.75–2.0) mm. in wing length.

Female: Similar to male; humeral seta on yellow, touching black, 8 humeral setulae; second dorsocentral 0.55 the length of the third; inner postalar 0.6 the length of the outer; wings with r-m cross vein at center (1.0: 1) of cell 1-M_2; m-m cross vein more than (1.3: 1) its own

[3]Meaning "long, hanging down," in reference to the elongate pile of frass upon which the larva pupates. This is about one-half as long as the puparium.

length from r-m, at a slight angle to penultimate section of M_{1+2}; size, 1.75 mm. in wing length.

Holotype ♂: Albany, Alameda County, California, IX-28-1948 (K. E. Frick), reared from a larva mining a leaf of *Aster chilensis* Nees, deposited in the California Academy of Sciences, San Francisco, California. *Allotype* ♀. Topotypical, VI-23-1948, same data as holotype. *Paratypes:* 4 ♂♂, 3 ♀ ♀, topotypical, VII-21 and IX-28-1948, same data as the holotype.

There are five specimens in the Canadian National Collection that I am placing here although three are slightly larger (♂ = 2–2.25 mm; ♀ = 2.5 mm.).These are 2♂♂ and 1 ♀ from Fort Churchill, Manitoba, V-17-1952 (J. G. Chillcott), ecological data f-B 12. The other two are a male and a female from Ottawa, Ontario, V-22-1946 (A. Brooks).

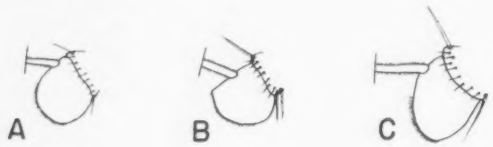

FIG. 1

FIG. 1. Third antennal segments: a, holotype of *P. promissa;* b, *P. humeralis;* c, holotype of *P. flavinotum.*

Frick (1952) included this species in his concept of *jucunda*. The larvae are easily distinguished from those of *jucunda*, as is the manner of pupation. Each puparium of *promissa* is upon a slender pile of frass of about one-half the puparial length. The puparia of *jucunda* are on a mass of frass about one-fifteenth the puparial length. The adults are separated with some difficulty, the best character being the relative length of the second dorsocentral to the third. In *promissa* this seta is more than one-half as long while in *jucunda* it is one-half or less. The length of the darkening of the geno-vertical plates is of some value, but a degree of overlapping exists. In 44% of the specimens the darkening is to midway between the dorsal and ventral upper-orbitals and in 56% to the ventral upper-orbital. In *jucunda*, 21% have the genovertical plates dark to between these setae and in 8% to the lower upper-orbital, while 71% are dark only to the dorsal upper-orbital.

Mature larva. Grayish-white. Mandibles black, broad, rectangular, angular, subequal in size, each with two pairs of teeth approximate; small ventrally directed anteroventral protrusion not always present; a rounded protrusion ventrad of lower tooth of right mandible (fig. 5a). Anterior spiracles each subconical, slightly expanded distally, bearing about 6 spiracular bulbs placed in a dorsally arched line. Posterior spiracles (fig. 5b) each subconical, somewhat expanded distally, bearing from 5 to 8 ovoid, brown spiracular bulbs in a circle opening toward the midline of the body (fig. 5e). Posterior end bare, no cuticular process or papillae; anal lobes very broadly rounded (fig. 5c). Abdominal cuticular processes (fig. 5d) in irregular rows, posterior several rows in each band having processes about 2 to 3 times as large as those anteriorly situated; bands wide, about equal in width to bare segmental areas. Size: about 3.5 mm. in length, about 0.8 mm. in width.

The larvae of *promissa* are easily distinguished by the very broadly rounded anal lobes and by the circular posterior spiracles, these latter being irregular or with three bulbs in other species. The mandibles are unique in being subequal in size and in having the teeth very close to each other.

Leaf mines. Large white blotch, turning brown with age on dorsal surface; frass centrally deposited on ventral epidermis below midrib in pellets and streaks coalescing to form a black mass; emergence slit at edge of mine (fig. 11a). Mines beginning as linear until the midrib is reached, then becoming blotch, which soon obliterates the linear portion (fig. 11b). One mine per leaf, laterally centralized on the midrib.

The leaf mines may be distinguished by the central mass of frass, the nearly circular outline of the mine, even when small, centered around the midrib, and the long thin pile of frass upon which pupation takes place.

3. **Phytobia (Calycomyza) jucunda** (van der Wulp)

Agromyza jucunda van der Wulp, 1867, Tijdschr. Ent., 10: 161; Coquillett *p. p.*, 1898, U. S. Dept. Agric., Div. Ent. Bull. 10: 77; Aldrich, 1905, Smithson. Misc. Coll., 46: 648; Malloch, 1918, Canad. Ent., 50: 317; Hendel, 1920, Arch. Nat., Abt. A, 84: 136.

Dizygomyza (Calycomyza) jucunda (van der Wulp), Hering, 1951, Not. Ent., 31: 42.

Phytobia (Calycomyza) jucunda (van der Wulp), Frick, 1952, Univ. Calif. Publ. Ent., 8: 395.

Agromyza platyptera Thomson, 1868, Dipt. Freg. Eugen. Resa, (2)6(12): 608; Melander, 1913, Jour. New York Ent. Soc., 21: 257; Malloch, 1913, Ann. Ent. Soc. Amer., 6: 293; Frost, 1924, Cornell Univ. Agric. Exp. Sta. Mem., 78: 50.

Agromyza coronata Loew, 1869, Berl. ent. Zeitschr., 13:48; Aldrich, 1905, Smithson. Misc. Coll., 46: 648; Melander, 1913, Jour. New York Ent. Soc., 21: 257; Frost, 1924, Cornell Univ. Agric. Exp. Sta. Mem., 78: 49; Hendel, 1936, *in* Linder, Die Flieg. palaearkt. Reg., 59: 562. New synonymy.

Phytobia (Calycomyza) coronata (Loew), Shewell, 1953, Canad. Ent., 85: 466.

Adult (23 specimens). Head (profile): eye 1.4 (1.3–1.5) times as high as long; gena 0.2 (0.2–0.3) of the eye height; genovertical plates slightly extending anteriorly of eyes dorsad of antennae; third antennal segment round (fig. 1a). Head (front view): genovertical plates dark from vertex to dorsal upper-orbital (71%), to half-way between the two upper-orbitals (21%), to ventral

upper-orbital (8%); mesofacial plate about one-half yellow, black of dorsal half extending laterally to eyes. Mesonotum: subshining; humeral seta on or touching black (86%) or on yellow and not touching black (14%), 4 to 6 humeral setulae; 6 irregular rows of acrostichals between the dorsocentral rows; second dorsocentral seta 0.4 (0.25–0.50) the length of the third; inner postalar 0.5 (0.4–0.75) the length of the outer. Legs: midtibiae each without (50%) or with 1 barely distinguishable posterolateral spur. Wings: margin and fringe of calypter white; r-m cross vein distal to, 1.4: 1 (1.0–2.0), center of cell 1–M_2; m-m cross vein about, 1.1: 1 (0.7–1.5), of its own length from r-m, at a slight angle or perpendicular to penultimate section of M_{1+2}; ultimate section of M_{3+4} 3(2.5–4) times as long as penultimate. Size: 1.5 (♂ = 1.5–1.75; ♀ = 1.6–2.0) mm. in wing length.

Holotype (sex?). Kumlion (or Kumlien?), Wisconsin, deposited in the Rijskmuseum van Natuurlijke Historie, Leiden, Netherlands. *Holotype* of *platyptera*, ♀. California (Kinb.), deposited in the Naturhistoriska Riksmuseum, Stockholm, No. 153. *Syntypes* of *coronata*. 1 ♀, labelled "*coronata* m," and 1♂, "Penn.," each bearing the label; "Loew coll." and an M. C. Z. type label, both deposited in the Museum of Comparative Zoology, Cambridge, Massachusetts. The Cuban specimens mentioned by Loew do not belong here as these two have the margin and fringe of the calypter black.

Several different species, some with black-fringed calypters, have been included under the name *jucunda*. The concept of Frick (1952) is correct as shown by a subsequent study of type specimens. The description is based upon two homotypes labelled by Dr. A. Diakonoff at the Rijksmuseum van Naturlijke Historie plus a series of 21 reared specimens in my collection. Dr. Diakonoff compared my specimens with van der Wulp's type after I had determined that they were the same as the holotype of *platyptera* Thomson, kindly lent by Dr. René Malaise. A study of the syntypes of *coronta* showed that it is a synonym of *jucunda* and not *humeralis*, where Hendel (1936), Hering (1951), and Frick (1952) had placed it.

The host plant record of *Aster chilensis* Nees (Frick, 1952) is in error as specimens from this host are distinct and are herein described as *promissa* n. sp. Several new host plant records were found among the specimens studied and these are listed here by States: *Ambrosia trifida* (Illinois), *Artemisia douglasiana* (California), *Baccharis viminea* (California), *Arctium* sp. (Indiana), *Erigeron* sp. (Louisiana), Globe artichoke (Louisiana), *Grindelia squarrosa* (California, Texas), *Solidago* sp. (New York, Pennsylvania, Washington, D. C.), *Xanthium* sp. (California, Indiana), and *Zinnia* sp. (California, Virginia). All known host plants are listed in Table I.

P. jucunda appears to be Nearctic in distribution. Blanchard in 1954 decided that an earlier record for the species in Argentina was in error and included it in his new species, *jucundacea*. Prof. Hering has written that *jucunda* is unknown in Europe. I have seen specimens from Washington, California, Utah, Kansas, Texas, Louisiana, Iowa, Illinois, Indiana, Michigan, New York, Pennsylvania, New Jersey, Maryland, Washington, D. C., Virginia, Georgia, and Florida in the United States, Saskatchewan, Manitoba, Ontario, and Nova Scotia in Canada, and in Hawaii. This species appears to be the most common one in the United States and has a wide range of larval host plants in the family Compositae.

This species is very close to *promissa* in the adult stage but can be separated by the relative length of the second to the third dorsocentral. In *jucunda* the second is one-half or less the length of the third, while in *promissa* it is more half. In *jucunda* the genovertical plates are not usually dark beyond the dorsal upper-orbital while in *promissa* these plates are black to at least between the two upper-orbitals, but some overlapping exists.

Mature larva. Grayish-white. Mandibles black, subrectangular, broadly and smoothly rounded dorsally, four teeth subequal in size and spacing, anteroventral protrusion about half as long as a tooth (fig. 6a). Anterior spiracles each subconical, broadly rounded but not expanded distally, bearing about 6 spiracular bulbs placed in a dorsally arched row. Posterior spiracles each subconical, bearing 3 elongate, brown spiracular bulbs, outwardly directed, central bulb about two-thirds as long as either anterior or posterior bulb. Posterior end bearing 3 papillae on each side in an anteriorly descending line (fig. 6c); anal lobes of moderate size, subconical, bearing colorless blunt processes (fig. 6c, e). Abdominal cuticular processes minute (fig. 6d), about half as large as the largest of *promissa*, in very irregular rows; anterior 2 to 4 rows and posterior 6 to 8 rows in each band bear processes 2 to 4 times as large as the nearly invisible (at 430 X) central processes; bands about half as wide as bare segmental areas. Size: about 4 mm. in length and 0.75 mm. in width.

The larvae of *jucunda* may be distinguished from those of *promissa* and *humeralis* in that each of the posterior spiracles of *jucunda* has three bulbs. Unlike the larvae of *artemisiae* and *majuscula*, both of which have three bulbs on these spiracles, the larvae of *jucunda* lack strongly differentiated anal lobes. These lobes are relatively short, not flattened distally, and bear colorless processes in *jucunda*. Also, larvae of *jucunda* lack the patch of abdominal processes on the posterior end ventrad of the spiracles.

Leaf mines. Those in *Artemisia vulgaris* considered as typical. Large white blotch, turning

brown with age, on dorsal surface; frass mostly deposited in a mass of small coalescing pellets around pupation site, otherwise very small pellets thinly scattered about, sometimes in small groups (fig. 13a). Mines beginning as short, rarely curving linear, becoming blotch, which usually obliterates the linear portion (fig. 13b); frass not visible in linear mine. One mine per leaf, laterally centralized on the midrib.

Mines in *Helianthus annuus* atypical. Large greenish blotch, turning brown or white with age (fig. 12a); usually on ventral surface; not extending through to opposite epidermis, therefore, giving mine a greenish color and hardly visible on reverse side of leaf. Mines beginning as rarely curving linear, becoming blotch, which usually obliterates linear portion (fig. 12b); frass not visible in linear mine. Usually several, up to six mines per leaf.

The mines of *jucunda* may be distinguished from those of *humeralis* by the lack of visible frass in the linear mine, the shorter linear portion that is usually destroyed as the blotch enlarges, and by the frass being deposited largely near the center at the pupation site. The mines of *promissa* are very similar but those of *jucunda* are more irregular in outline, particularly at the beginning and do have some of the frass scattered about in the mine. Also the puparia of *jucunda* are on a very short pile of frass of about one-fifteenth the puparial length.

4. **Phytobia** (**Calycomyza**) **humeralis** (von Roser)

Agromyza humeralis von Roser, 1840, Korresp.-Bl. wuertt. landw. Ver., 8: 63.

Dizygomyza (*Calycomyza*) *humeralis* (von Roser), Hendel, 1931, *in* Lindner, Die Flieg. palaearkt. Reg., 59: 68; de Meijere, 1938, Tijdschr. Ent., 81: 75; 1940, Tijdschr. Ent., 83: 175 (as *Calycomyza* sp.); 1943, Tijdschr. Ent., 86: 68; Hering, 1951, Not. Ent., 31: 42.

Phytobia (*Calycomyza*) *humeralis* (von Roser), Frick, 1952, Univ. Calif. Publ. Ent., 8: 394.

Agromyza bellidis Kaltenbach, 1858, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 15: 82.

Dizygomyza bellidis (Kaltenbach), Hendel, 1920, Arch. Nat., Abt. A., 84: 136; 1923, Deutsch. ent. Zeitschr., 1923: 394; de Meijere, 1925, Tijdschr. Ent., 68: 257; Hering 1925, Zeitschr. wiss. Ins. Biol., 20: 133; 1927, Tierw. Deutschl., 6: 57.

Adult (17 specimens). Head (profile): eye 1.3 (1.3–1.5) times as high as long; gena 0.3 (0.25–0.3) of the eye height; genovertical plates only slightly extending anteriorly of eyes near antennae; third antennal segment strongly angled dorsoanteriorly (fig. 1b). Head (front view): genovertical plates dark from vertex to halfway between two upper-orbitals (12%), to ventral upper-orbital (18%), to dorsal lower-orbital (41%), to ventral lower-orbital (29%); mesofacial plate black ventrally to epistoma and laterally to eyes. Mesonotum: shining; humeral seta on black, usually 3, sometimes 4, rarely 5 humeral setulae; 5 irregular rows of acrostichals between the dorsocentral rows; second dorsocentral seta 0.5 (0.3–0.7) the length of the third; inner postalar 0.3 (0.25–0.4) the length of the outer. Legs: mid-tibiae each with 1 posterolateral spur. Wings: margin and fringe of calypter white; r-m cross vein near center, 1.1: 1 (0.7–1.5), of cell $1\text{–}M_2$; m-m cross vein about, 1: 1 (0.6–1.5), its own length from r-m, perpendicular or at a slight angle to the penultimate section of M_{1+2}; ultimate section of M_{3+4} 3 (2.5–3.5) times as long as penultimate. Size: 1.6 (♂ = 1.4–1.75; ♀ = 1.6–1.75) mm. in wing length.

Von Roser's original description of "nigra, humeris albis" Hendel considered as a *nomen nudum* until 1931 when he had studied the holotype. The location of this type has not been published. A study of the syntypes of *coronata* Loew, 1869, showed that it is a synonym of *jucunda* and not of *humeralis*. The series used in the description consisted of two from Europe, ex *Bellis perennis* L., and 15 from Mt. Hermon, Santa Cruz County, California, VII-12, VIII-28, IX-2-1948 (K. E. Frick), ex *Heterotheca grandiflora* Nutt.

In 1952, Frick listed the larval host plants from which he had reared this species, except for *Pentstemon procerus* at Hope Valley, Alpine County, California, VIII-5-1948 (K. E. Frick). Subsequent study showed that both the larvae and adults agreed with those of *humeralis*. This is the first record of the larvae of *humeralis* mining in any plant of the family Scrophulariaceae (Table 1). There are two males in the Canadian National Collection from Great Whale River, Quebec, VIII-15-1949 (J. R. Vockeroth), ex *Solidago macrophylla*. Frost (1924) lists several other host plants, but because of the confusion that previously has existed concerning the identification of the several species and the fact that I was unable to study his entire collection in the alloted time, it is thought best not to include the records at this time.

P. humeralis is most similar to *solidaginis* in having an angled third antennal segment and five rows of acrostichals. These two species are easily separated by the color of the mesofacial plate, which is black in *humeralis* and yellow in *solidaginis*.

I have examined specimens from California, Oregon, Washington, Arizona, Iowa, Kansas, and Indiana in the United States, from Saskatchewan,

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EXPLANATION OF PLATE I

FIGS. 2–6. Larval characters. FIG. 2. *P. artemisiae*. FIG. 3. *P. majuscula*. FIG. 4. *P. humeralis*. FIG. 5. *P. promissa*. FIG. 6. *P. jucunda*. a, mandibles; b, posterior spiracles (fig. 2 and 6 same as fig. 3); c, posterior end (lateral view); d, cuticular processes; e, posterior end (dorsal view) (fig. 3 same as fig. 2). The black line in fig. 2 equals 0.5 mm., and is for the figures of the posterior end. Mandibles greatly enlarged, drawn to the same scale from the right side (if from ventral view) of larva. Posterior spiracles and abdominal cuticular processes greatly enlarged, not drawn to the same scale.

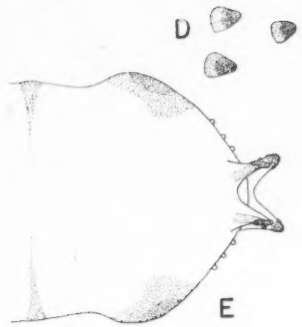
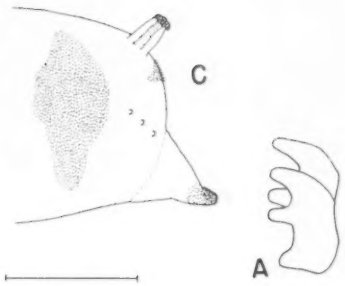


FIG. 2



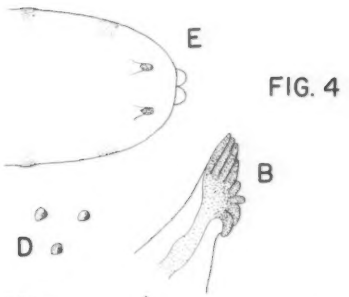


FIG. 4

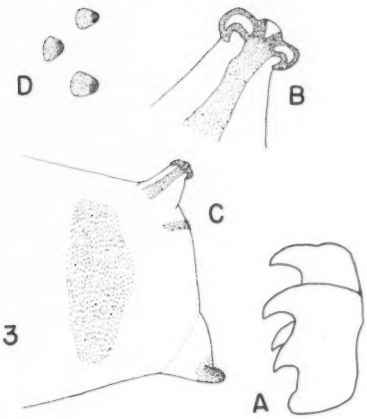
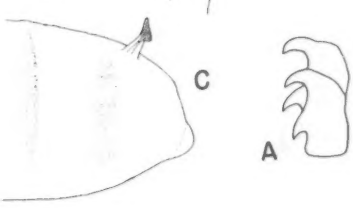


FIG. 3



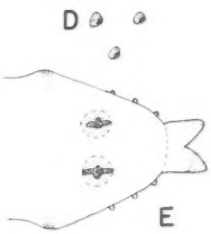


FIG. 6

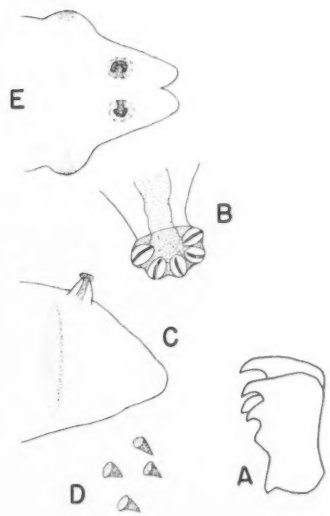
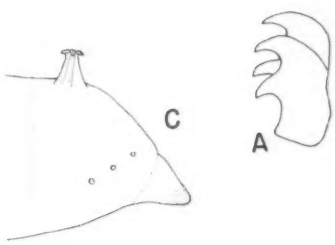


FIG. 5



Ontario, and Quebec in Canada, and from Hawaii.

Mature larva. Grayish-white. Mandibles black, subrectangular, dorsal pair of teeth widely separated, dorsalmost nearly straight, ventral 3 teeth subequal in size and spacing (fig. 4a). Anterior spiracles subconical, broadly rounded and slightly expanded distally, each bearing 5 to 7 ovoid spiracular bulbs in a dorsally arched line. Posterior spiracles each irregular, bearing 3 or 4 elongate slender brown spiracular bulbs in a dorsally directed cone; plus about 4 elongate, but shorter and broader, bulbs laterally, directed outwardly from midline of larva (fig. 4b). Posterior end bare, without cuticular processes or papillae; anal lobes small, broadly rounded, each bearing some small colorless papillae (fig. 4c, e). Abdominal cuticular processes similar to those of *jucunda* (fig. 4d); in irregular rows, processes of posterior 2 or 3 rows of each band about twice the size of those anteriorly situated; bands each about half as wide as bare segmental areas. Size: about 2.5 mm. in length and 0.7 mm. in width.

The larvae of *humeralis* are most distinctive in the irregular form of the posterior spiracles. The mandibles are unusual in having the dorsalmost tooth not at the same angle as the other teeth but relatively widely separated and perpendicular to the axis of the mandibles.

Leaf mines. Greenish-white blotch or linear-blotch on broad leaves (cultivated *Aster* sp., fig. 10) or elongate, very irregular blotch or linear-blotch on narrow leaves (*Erigeron canadensis*, fig. 9); frass in small black pellets along center line of linear mine (fig. 9b), in trails in blotch showing in general the movements of larva, which are frequently twisting. Mines beginning as elongate, curving linear, becoming blotch by doubling back of larva, often not obliterating linear portion (fig. 9a). Usually one mine per leaf; laterally situated, except in very small leaves when usually centered (fig. 10b); eventually expanding to include whole leaf.

Examples of mines were chosen from a relatively broad and a relatively narrow leaf. These mines are similar in having a long slender linear mine widening into an elongate irregular blotch. The mines of *humeralis* are most distinctive in that the frass is deposited in tiny rounded pellets in a row down the center of the long linear portion. Also, the general movements of the larva as it formed the mine can be traced by the lines of frass pellets. The somewhat similar mines of *promissa* (fig. 11) and *jucunda* (figs. 12 and 13) have a much shorter linear portion and have nearly all of the frass deposited in a central mass.

5. **Phytobia (Calycomyza) solidaginis** (Kaltenbach)

Agromyza solidaginis Kaltenbach, 1869, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 26: 196.

Dizygomyza solidaginis (Kaltenbach), Hering, 1925, Zeitschr. wiss. Ins. Biol., 20: 133; 1927, Tierw. Deutschl., 6: 56.

Dizygomyza (Calycomyza) solidaginis (Kaltenbach), Hendel, 1931, *in* Lindner, Die Flieg. palaearkt. Reg., 59:69; Hering, 1951, Not. Ent., 31: 42.

Phytobia (Calycomyza) solidaginis (Kaltenbach), Frick, 1953, Canad. Ent., 85: 70.

Dizygomyza bellidis (Kaltenbach, 1858), Hendel *p. p.*, 1920, Arch. Nat., Abt. A., 84: 136; 1923, Deutsch. ent. Zeitschr., 1923: 394.

Adult (15 specimens). Head (profile): eye 1.4 (1.25–1.5) times as high as long; gena 0.24 (0.22–0.26) of the eye height; genovertical plates moderately extending anteriorly of eyes dorsad of antennae; third antennal segment strongly angled dorsoanteriorly (fig. 1b). Head (front view): genovertical plates broadly dark from vertex at least to dorsal upper-orbital, usually to ventral upper-orbital, often to ventral lower-orbital; mesofacial plate yellow. Mesonotum: subshining; humeral seta on or touching black, usually 3 or 4, rarely 2, 5, or 6 humeral setulae; 5 irregular rows of acrostichals between the dorsocentral rows; second dorsocentral 0.5 (0.4–0.7) the length of the third; inner postalar 0.5 (0.4–0.5) the length of the outer. Legs: mid-tibiae each without (66%) or with 1 small (33%) posterolateral spur. Wings: margin and fringe of calypter yellow; r-m cross vein basal to, 0.7: 1 (0.5–1.0), center of cell 1–M_2; m-m cross vein about, 1.1: 1 (0.7–1.5), of its own length from r-m, perpendicular or at a slight angle to the penultimate section of M_{1+1}; ultimate section of M_{3+4} 2.6 (2.3–3.0) times as long as penultimate. Size: 1.6 (♂ = 1.5–1.6; ♀ = 1.6–1.75) mm. in wing length.

Hendel included the *Solidago*-mining species in his concept of *bellidis* (a synonym of *humeralis*) but Hering (1925) separated the species from *Solidago* by the yellow mesofacial plate, which is black in *humeralis*. The larvae are very similar to those of *humeralis* (fig. 4) according to Hendel (1931). The species has been reared only from *Solidago virga-aurea* L. in Europe.

North American specimens have been reared from *Solidago* spp. in New York (Osten Sacken),

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EXPLANATION OF PLATE II

FIGS. 7–13. Characteristics of leaf mines. FIG. 7. Mines of *P. majuscula* on *Senecio lugens* var. *exaltatus* Gray; a, mature mine on left, immature on right; b, detail of start of mine. FIG. 8. Mines of *P. artemisiae* on *Artemisia vulgaris* L.; a, mature mine and two immature mines; b and c, details of immature mines. FIG. 9. Mines of *P. humeralis* on *Erigeron canadensis* L.; a, mature mine on right, immature on left; b, detail of immature mine. FIG. 10. Mines of *P. humeralis* on *Aster* sp.; a, mature mine, b, immature mine. FIG. 11. Mines of *P. promissa* on *Aster chilensis* Nees; a, mature mine; b, immature mine. FIG. 12. Mines of *P. jucunda* on *Helianthus annuus* L.; a, mature mine; b, immature mine. FIG. 13. Mines of *P. jucunda* on *Artemisia vulgaris* L.; a, mature mine; b, immature mine. Each straight line is equal to 10 mm.

FIG. 7

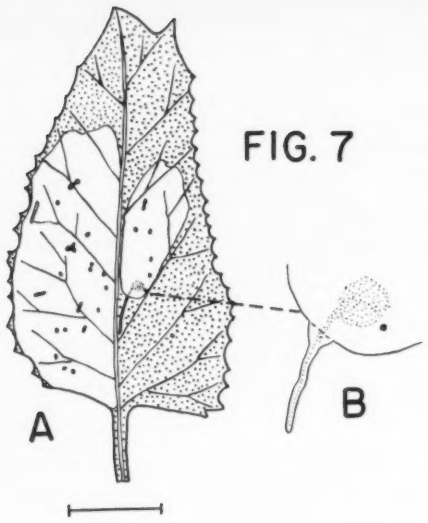


FIG. 8

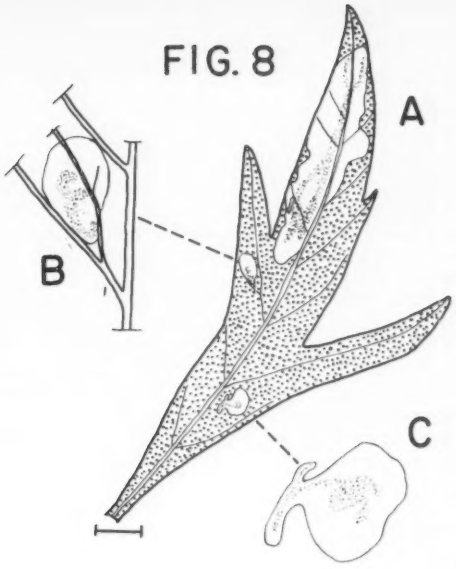


FIG. 9

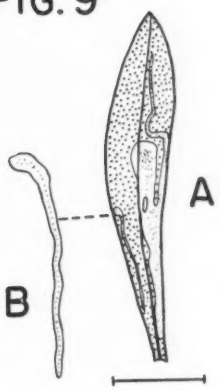


FIG. 10

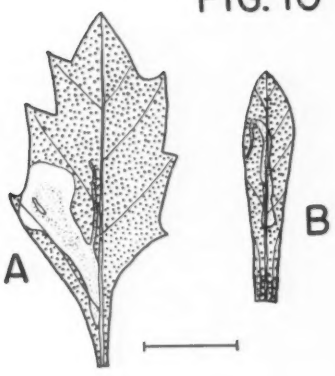


FIG. 11

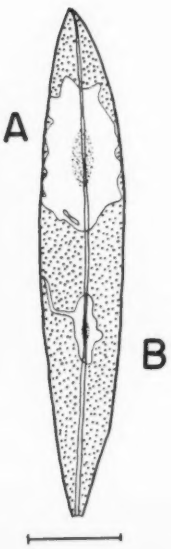


FIG. 12

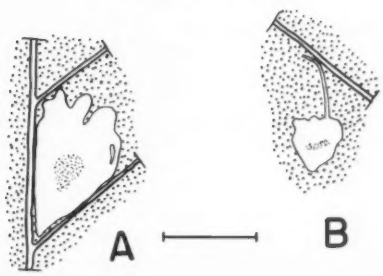
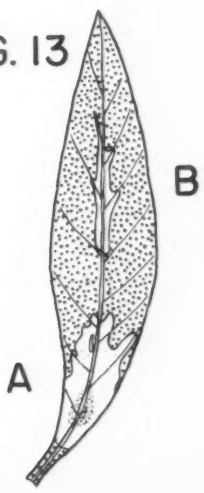


FIG. 13



Florence, South Carolina, VI-1-1943 (C. N. Hoffman), and Waynesboro, Georgia, V-26-1943 (C. N. Hoffman). I have studied specimens from California, New Mexico, Colorado, Iowa, Wisconsin, Michigan, Indiana, New York, Maryland, and Louisiana in the United States and from Ontario and Nova Scotia in Canada. *P. solidaginis* does not seem to be common anywhere in North America, although I did get the series of 15 used for the description by sweeping in Hope Valley, Alpine County, California, VIII-5 to 8-1948.

There is a puparium with the Waynesboro specimen. It has the posterior spiracles very much like those of *humeralis* (fig. 4b), but they are not quite as elongate dorsally.

6. **Phytobia (Calycomyza) artemisiae**
(Kaltenbach)

Agromyza artemisiae Kaltenbach, 1856, Verh. naturh. Ver. preuss. Rheinl. und Westphal., 13: 236.
Dizygomyza artemisiae (Kaltenbach), Hendel, 1920, Arch. Nat., Abt. A, 84: 136; de Meijere, 1925, Tijdschr. Ent., 68: 255; Hering, 1927, Tierw. Deutschl., 6: 56.
Dizygomyza (Calcycomyza) artemisiae (Kaltenbach), Hendel, 1931, *in* Lindner, Die Flieg. palaearkt. Reg., 59: 66; Hering, 1951, Not. Ent., 31: 42.
Phytobia (Calcomyza) artemisiae (Kaltenbach), Frick, 1952, Univ. Calif. Publ. Ent., 8: 394.

Adult (7 specimens). Head (profile): 1.5 (1.4–1.6) times as high as long; gena 0.2 (0.18–0.25) of the eye height; genovertical plates not extending anteriorly of eyes; third antennal segment rounded. Head (front view): genovertical plates dark to dorsal upper-orbital, 2, rarely 3, lower-orbitals on either side; frontal vitta broad, 1.1 (1.0–1.2) times as high as wide; mesofacial plate dorsally about one-half black. Mesonotum: subshining; humeral seta on yellow, touching black, 12 (9–14) humeral setulae; 6 irregular rows of acrostichals between the dorsocentral rows; second dorso-central 0.5 (0.4–0.5) the length of the third; inner postalar 0.4 (0.3–0.5) the length of the outer. Legs: mid-tibiae each with 1 or 2 posterolateral spurs. Wings: margin and fringe of calypter black; r-m cross vein distal to, 1.5: 1 (1.0–2.0), of cell 1–M_2; m-m cross vein about equal (0.75–1.1) to its own length from r-m, perpendicular to the penultimate section of M_{1+2}; ultimate section of M_{3+4} 2.2 (2.0–2.4) times as long as penultimate. Size: 2.0–2.25 mm. in wing length.

Described from two specimens presented to me by Prof. Hering and five reared from *Artemisia vulgaris* L. in California (Frick, 1952). *P. artemisiae* is relatively rare with only a few specimens being taken at any one locality. I have seen one reared from *Artemisia douglasiana*, Long Beach, California (B. J. Rohrer) and another reared from *Rudbeckia*, cultivated var., Arendtsville, Pennsylvania, VII-10-1929 (S. W. Frost). Otherwise, I have seen only 28 specimens from Washington, Oregon, California, Arizona, New Mexico, Kansas, and Texas in the United States. There are three in the Canadian National Collection from British Columbia and Ontario. Frost has a female from El Salto, Antigua, Guatamala, V-1-? (J. M. Aldrich).

P. artemisiae may be distinguished from the other two species in the group with the mesofacial plate at least one-half dark by the short darkening of the genovertical plates. These plates are dark only to the dorsal upper-orbital in *artemisiae* but at least to the ventral upper-orbital in the other species, *cynoglossi*, *majuscula*, and *gigantea*. *P. artemisiae* may be confused with *verbenae*, but *verbenae* has a narrow frontal vitta (not less than 1.7 times as high as wide) while the frontal vitta is about as high as wide in *artemisiae*. The mesofacial plate is yellow in *verbenae* and also in *allecta*, another superficially similar species.

Mature larva. Grayish-white. Mandibles black, teeth bluntly rounded, evenly alternating, appearing to be 5 in number because of an antero-ventral protrusion (fig. 2a). Anterior spiracles each conical, broadly rounded, but not expanded distally; bearing about 10 irregularly placed circular spiracular bulbs. Posterior spiracles each subconical, bearing 3 elongate, brown spiracular bulbs; central bulb outwardly directed and about two-thirds as long as anterior and posterior bulbs (as in *majuscula*, fig. 3b). Posterior end bearing a patch of cuticular processes ventral to posterior spiracles and, on either side, a ventrally descending row of 3 colorless, rounded papillae; anal lobes elongate, distally each with a dorsal, brown, sclerotized area, bearing many brown to black blunt processes, particularly dorsally (fig. 2c, e). Abdominal cuticular processes subtriangular (fig. 2d), in moderately wide intersegmental bands, each about one-third to one-half of bare segmental areas; largest processes centrally, smaller anteriorly and posteriorly, very irregularly spaced, rows short, curved; posteriormost band the widest, on laterally expanded intersegmental area (fig. 2c, e). Size: about 4 mm. in length, 0.75 to 1.0 mm. in width.

The larvae of *artemisiae* belong to the group having long, distally flattened anal lobes that bear brown or black cone-shaped processes and that leave the mines to pupate. This group includes *majuscula*, *flavinotum*, and *allecta*. The description and figures of the larvae of *allecta s. lat.* (Frost, 1924) are inadequate to separate them from those of *artemisiae*. From *majuscula* larvae, *artemisiae* larvae differ in that the teeth of the mandibles are directed straight outward or slightly upward and are quite evenly spaced. There is a row of three papillae on either side of the posterior end that are lacking in *majuscula*.

Leaf mines. Large greenish-white blotch, turning brown with age; frass deposited in very small pellets usually broadly centrally throughout the length of mine, upper epidermis discolored brown

in areas of frass concentration (fig. 8a). Most mines beginning as a blotch (fig. 8b), but a short serpentine mine sometimes formed before the blotch (fig. 8c), which mine the blotch soon obliterates. One mine per leaf.

The mines of *artemisiae* always have been single per leaf with each containing one larva. This is in contrast to *majuscula* which frequently has several larvae in a large mine formed by several coalescing. The mines of *flavinotum* (Frost, 1924, Plate II, fig. 2) usually have several larvae in each according to Frost. The frass is deposited in very tiny pellets by the larvae of *artemisiae* while those of *majuscula* larvae are large.

7. **Phytobia (Calycomyza) cynoglossi,** new species

Agromyza jucunda (van der Wulp), Aldrich *p. p., in* Tower, 1915, Jour. Econ. Ent., 8: 431; Frost, 1924, Cornell Univ. Agric. Exp. Sta. Mem., 78: 143, 179.

Male. Head (profile): eye 1.5 (1.2–1.5) times as high as long; gena 0.2 (0.13–0.25) of the eye height; genovertical plates slightly extending anteriorly of eyes; third antennal segment round. Head (front view): genovertical plates dark to ventral upper-orbital, dusky to dorsal lower-orbital, 2 (2–3) lower-orbitals on either side; mesofacial plate two-thirds dark, extending laterally to eyes. Mesonotum: subshining; humeral seta on black, 12 (9–13) humeral setulae; 6 irregular rows of acrostichals between the dorsocentral rows; second dorsocentral 0.4 (0.3–0.4) the length of the third; inner postalar 0.5 (0.4–0.6) the length of the outer. Abdomen: most tergites very narrowly yellow distally. Legs: mid-tibiae each with 2 (rarely 1 or 3) posterolateral spurs. Wings: margin and fringe of calypter black; r-m cross vein distal of, 2.5: 1 (1.25–3.0), center of cell 1-M_2; m-m cross vein less than, 0.7: 1 (0.7–1.2), its own length from r-m, at a moderate angle (rarely at a strong angle or perpendicular) to penultimate section of M_{1+2}; ultimate section of M_{3+4} 2.5 (2–3) times as long as penultimate. Size: 2.0 (♂ = 1.75–2.0; ♀ = 1.75–2.25) mm. in wing length.

Female: Very similar to male; eye 1.4 times as high as long; gena 0.25 of the eye height; mesofacial plate two-thirds dark; m-m cross vein at its own length from r-m; 2.25 mm. in wing length.

Holotype ♂. Lafayette, Indiana, IX-22-? (J. M. Aldrich), "Leaf-miner in *Cynoglossum*," deposited in the United States National Museum, Washington, D. C. *Allotype* ♀. Topotypical, same data as holotype. *Paratypes.* 8 ♂♂, 14 ♀♀, topotypical, IX-1, 20, 22, 27–?, same data as holotype; 1 ♀, Abbotsford, Quebec, Canada, IX-17-1936 (G. E. Shewell).

There are 24 reared specimens from cage 42b, collected by Aldrich, that bear the following statement on the label: "One parent of the following series with 5 orbitals on *one side.*" That could only mean that there were three lower-orbitals on one side. Of this series 70 percent have two on either side and 30 percent have two on one side and three on the other. These figures might be compared with the type series in which 72 percent have two lower-orbitals on either side, 24 percent with three on one side, and 4 percent with three on both sides. There are other, apparently unreared, specimens from Aldrich's years (1913–1918) at Lafayette.

There are unreared specimens of this species from Kansas, Michigan, Wisconsin, Virginia, New Jersey, Pennsylvania, New York, and Maine in the United States. Canadian specimens have been collected in British Columbia, Manitoba, Ontario, Quebec, New Brunswick, and Nova Scotia.

P. cynoglossi, majuscula, gigantea, and *artemisiae* may be separated from the remaining species in this group with black calypters by the dark mesofacial plate. *P. artemisiae* can be distinguished by having the genovertical plates dark only to the dorsal upper-orbital. *P. cynoglossi* may be separated from *majuscula* and *gigantea* by the genovertical plates being darkened not farther than to the dorsal lower-orbital and the second dorsocentral seta distinctly less than one-half the third. Also, the genovertical plates only slightly exceed the eyes and the size is smaller (1.75–2.25 mm.) than *majuscula* and *gigantea* (2.25–3.25 mm.).

8. **Phytobia (Calycomyza) majuscula,** new species

Male: Head (profile): eye 1.2 (1.2–1.5) times as high as long; gena 0.23 (0.23–0.32) of the eye height; genovertical plates rather strongly extending (0.25–0.3 of the genal height) anteriorly of eyes dorsad of antennae; third antennal segment round. Head (front view): genovertical plates dark to ventral lower-orbital; 3 (2–4) lower-orbitals on either side; mesofacial plate black to epistoma, extending laterally to eyes. Mesonotum: shining; humeral seta on black, at edge, 5 and 6 (5–10) humeral setulae; 6 more or less regular rows of acrostichals between the dorsocentral rows; second dorsocentral 0.6 (0.5–0.7) the length of the third, rarely four postsuturals, sometimes a presutural dorsocentral present; inner postalar 0.67 (0.4–0.8) the length of the outer. Abdomen: most tergites narrowly yellow posteriorly. Legs: mid-tibiae each with 1 or 2 posterolateral spurs; forefemora distally black. Wings: margin and fringe of calypter black; r-m cross vein distal to, 1.5: 1 (0.8–1.9), center of cell 1-M_2; m-m cross vein equal 1: 1 (0.9–1.5), its own length from r-m, perpendicular to penultimate section of M_{1+2}; ultimate section of M_{3+4} 1.8 (1.7–2.2) times as long as penultimate. Size: 2.3 (♂ = 2.0–2.5; ♀ = 1.75–2.5) mm. in wing length.

Female: Very similar to male; gena 0.3 of the eye height; 7 and 8 humeral setulae; second dorso-

central 0.5 of the third; wing with r-m distal to (1.3: 1) center of cell 1–M_2; size, 2.5 mm. in wing length.

Holotype ♂. Summit Luther Pass, El Dorado County, California, VIII-28-1948 (K. E. Frick), reared from a larva mining in a leaf of *Senecio lugens* var. *exaltatus* Gray, deposited in the California Academy of Sciences, San Francisco, California. *Allotype* ♀. Topotypical, same data as holotype, deposited in the United States National Museum, Washington, D. C. *Paratypes*. 1 ♀, Camp Sacramento, El Dorado County, California, VII-18-1949 (K. E. Frick), swept from a grassy meadow; 1♂, Moscow Mt., Idaho, VI-3-1949 (C. O. Esselbaugh), 1 ♀, Moscow Mt., Idaho, VI-3-1911 (A. L. Melander); 1♂, Tacoma, Washington, VIII-27-1911 (A. L. Melander), 2 ♂♂, Marmora, Ontario, IV-28 and 30-1952 (J. F. McAlpine); 1♀, Bell's Corner, Ontario, V-2-51 (J. F. McAlpine), 3♂♂, 1♀, Saskatoon,Saskatchewan, V-4 and 6-1939 (A. R. Brooks). Melander's two specimens were not before me when the description was prepared.

P. majuscula, *gigantea*, *artemisiae*, and *cynoglossi* belong to the group with the calypteral fringe black and the mesofacial plate being at least one-half dark. *P. majuscula* can be separated from *cynoglossi* and *artemisiae* in having the darkening on the genovertical plates extending to the ventral lower-orbital and the genovertical plates of *majuscula* extend anteriorly of the eyes rather strongly. *P. majuscula* may be distinguished from *gigantea* by the shining mesonotum, six rows of acrostichals, humeral seta on black, and the three or four, rarely five ,dorsocentrals of which there are at least six in *gigantea*.

Matura larva. Grayish-white. Mandibles black, subrectangular, dorsal pair of teeth widely separated; anteroventral protrusion nearly equal to teeth in length (fig. 3a). Anterior spiracles each conical, broadly rounded, but not expanded, distally; bearing about 15 irregularly placed circular spiracular bulbs. Posterior spiracles each subconical, bearing 3 elongate, brown spiracular bulbs; central bulb outwardly directed and about two-thirds as long as anterior and posterior bulbs (fig. 3b). Posterior end bearing a patch of cuticular processes ventral to posterior spiracles, no papillae; anal lobes moderately elongate, distally each with a dorsal, brown sclerotized area, bearing many brown to black blunt processes, particularly dorsally (fig. 3c). Abdominal cuticular processes blunt subtriangular (fig. 3d), in wide intersegmental bands, each nearly as wide as bare segmental areas, largest processes centrally, smaller anteriorly and posteriorly, very irregularly spaced definite rows; posterior-most band the widest (fig. 3c), on laterally expanded intersegmental area (as in *artemisiae*, fig. 2e). Size: about 4.25 mm. in length, about 1 mm. in width.

The larvae of *majuscula* belong to the group having long, distally flattened anal lobes that bear brown or black cone-shaped processes and that leave the mines to pupate. This group includes *allecta*, *flavinotum*, and *artemisiae*. The larvae of *majuscula* differ from those of *artemisiae* in having the mandibular teeth recurved and unevenly spaced, and in the lack of a row of papillae on the posterior end. Neither of these species can be separated from *allecta s. lat.*, based upon the description or figures given by Frost (1924).

Leaf mines. Large pale green blotch, turning brown with age; frass sparsely deposited in a few large, irregular, black pellets usually attached to ventral epidermis, rather evenly distributed throughout central area of mine (fig. 7a); larvae pupate in the ground. Mines beginning as short linear, soon becoming blotch; frass in small blotch deposited in small pellets in a circular area, appearing brown (fig. 7b). Usually one, frequently two separate mines per leaf.

The mines of *majuscula* are different from others that are known to me in the manner of frass deposition. In this species there are only a relatively few large scattered pellets. Also, like *allecta s. lat.* more than one larva is sometimes found in a mine. Of 10 mines, 6 had 1 larva, 1 had 2, 2 had 3, and 1 had 4 larvae. Multiple larvae in a mine are probably due to separate mines coalescing as the larvae grow.

9. **Phytobia (Calycomyza) gigantea,** new species

Agromyza platyptera (Thomson), Malloch *p. p.*, 1913, Ann. Ent. Soc. Amer., 6: 293.

Male: Head (profile): eye 1.5 (1.3–1.5) times as high as long; gena 0.27 (0.18–0.28) of the eye height; genovertical plates rather strongly extending (0.3–0.4 of the genal height) anteriorly of eyes dorsad of antennae; third antennal segment round. Head (front view): genovertical plates broadly dark to dorsal lower-orbital, narrowly dark ventrally, usually not as wide as distance from eye to setal bases; 4 (3–4) lower-orbitals on either side; mesofacial plate black to epistoma, usually extending laterally to eyes. Mesonotum: dull, pollinose; humeral seta on yellow, 1 or 2 setal-base diameters from black, 10 (10–18) humeral setulae; 4 or 5 sparse irregular rows of acrostichals between dorsocentrals, 2 or 3 rows posterior to third dorsocentral; second dorsocentral 0.75 (0.7–0.9) the length of the third, first postsutural dorsocentral 0.9 (0.5–0.9) the length of the second; 4 dorsocentrals posterior to transverse suture and 2 or 3 anterior to suture, subequal in length to the first postsutural dorsocentral; inner postalar 0.8 (0.6–0.9) the length of the outer. Abdomen: most tergites narrowly yellow posteriorly. Legs: mid-tibiae each with 2 (0-2) weak posterolateral spurs; fore-femora distally at most narrowly reddish, usually black. Wings: margin and fringe of calypter black; r-m

cross vein close to, 1.2: 1 (0.8–1.2), center of cell 1-M_2; m-m crossvein equal to, 1: 1 (0.8-2.0), its own length from r-m, perpendicular or at a slight angle to penultimate section of M_{1+2}; ultimate section of M_{3+4} 1.8 (1.8-2.6) times as long as penultimate. Size: 2.6 (♂ = 2.5–2.75; ♀ = 2.3–3.25) mm. in wing length.

Female: Very similar to male; gena 0.18 of the eye height; 3 lower-orbitals per side; 17 and 18 humeral setulae; r-m cross vein basal to (0.8: 1) center of cell 1-M_2; size, 3.25 mm. in wing length.

Holotype ♂. Cabin John Bridge, Maryland, IV-28-1912 (Knab and Malloch), deposited in the United States National Museum, Washington, D. C. *Allotype* ♀. Virginia near Plummers Island, Maryland, VI-28-1915 (W. L. McAtee), deposited in the collection of the United States Fish and Wildlife Service, Patuxent Research Refuge, Laurel, Maryland. Paratypes. 1 ♀, St. Joseph, Illinois, at Salt Fork, V-10-1914 (J. R. Malloch?); 3 ♀♀, Bell's Corner, Ontario, VI-4-1952 (J. F. McAlpine), swept from wild *Clematis;* 1 ♂, Niagara Glen, Ontario, VI-15-1926 (G. S. Walley); 1 ♂, Beech Grove, Quebec, VII-18-1951 (J. F. McAlpine); 1 ♀, Wakefield, Quebec, VI-26-1946 (G. S. Walley).

The holotype is the specimen that Malloch (1913) referred to as an abnormal specimen of *platyptera*. Before seeing the allotype and the Canadian paratypes, I had placed the other two specimens in with *majuscula*. The longer series of both species, made possible by the Canadian material, quickly convinced me that two species were present.

P. gigantea is most closely related to *majuscula*, not only in size, but by the very long second dorsocentral, the frequent presence of a fourth postsutural and of one or more presutural dorsocentrals. *P. gigantea* may be separated from *majuscula* by the dull, pollinose mesonotum, four or five very sparse rows of acrostichals, darkening of the genovertical plates narrowing below the dorsal lower-orbital, and the humeral seta being on yellow.

10. **Phytobia (Calycomyza) flavinotum,** new species

Agromyza allecta (Melander), Frost *p. p.*, 1924, Cornell Univ. Agric. Exp. Sta. Mem., 78: 38.

Male: Head (profile): eye 1.5 (1.4–1.5) times as high as long; gena 0.13 (0.13–0.15) of the eye height; genovertical plates very slightly extending anteriorly of eyes; third antennal segment ovoid, longer than wide (fig. 1c). Head (front view): genovertical plates yellow, black of vertex not extending anteriorly of inner vertical seta, 3 lower-orbitals on either side; mesofacial plate yellow. Mesonotum: subshining black, broadly bordered by yellow; presutural seta on yellow, touching black; supraalar on black, close to yellow; broadly yellow above wing base; outer postalar on yellow and black; inner postalar on yellow; fourth dorsocentral on yellow and black; humeral seta on yellow, 13 (13–20) humeral setulae; 7 (6–8) irregular rows of acrostichals between the dorsocentral rows; second dorsocentral 0.5 (0.4–0.6) of the third; inner postalar 0.4 (0.4–0.5) of the outer. Legs: mid-tibiae each with 2 (or 3) posterolateral spurs; fore-femora narrowly distally yellow, for about one-half the femoral diameter. Wings: margin and fringe of calypter black; r-m cross vein distal to, 1.6: 1 (1.3–2.0), center of cell 1-M_2; m-m cross vein about 1: 1 (0.7–1.0), its own length from r-m, perpendicular (or at a slight angle) to penultimate section of M_{1+2}; ultimate section of M_{3+4} 2.3 (2.3–2.6) times as long as penultimate. Size: 2.5 (♂ = 2.3–2.6; ♀ = 2.75–3.0) mm. in wing length.

Female: Very similar to male; 14 humeral setulae; second dorsocentral 0.6 the length of the third; r-m cross vein distal to (1.3: 1) center of cell 1-M_2; ultimate section of M_{3+4} 2.5 times the penultimate; size, 2.75 mm. in wing length.

Holotype ♂. Elma, New York, VIII-20-1911 (M. C. Van Duzee), deposited in the California Academy of Sciences, San Francisco, California. *Allotype* ♀. Madison, Wisconsin, VII-27-1917 (C. L. Fluke), deposited in the United States National Museum, Washington, D. C. *Paratypes.* ♀, same data as allotype; 1 ♀, Chester, Massachusetts, VIII-20-1911; 1 ♂, 1 ♀, Ithaca, New York, VIII-24-1916 (S. W. Frost), ex *Arctium lappa* L.; 2 ♂♂, 2 ♀♀, Ithaca, New York, VII-23-1916 (S. W. Frost), ex *Arctium lappa* L.; 2 ♀♀, Arendtsville, Pennsylvania, VIII-16-1920 (S. W. Frost), ex *Eupatorium purpureum;* 1 ♂, Ottawa, Ontario, VIII-19-1946 (G. E. Shewell), ex *Virburnum pubescens;* 1 ♀, Ottawa, Ontario, VII-19-1946 (A. Brooks).

Frost (1924) included two species in his concept of *allecta*. Frost's specimens from *Arctium lappa* and *Eupatorium purpureum* are distinct from his specimens reared from *Bidens*, *Helianthus*, and *Rudbeckia* spp. The specimens whose larvae mine the three last-mentioned hosts belong in *allecta s. str.*

P. flavinotum is most closely related to *allecta* in having the ovoid third antennal segment and the lack of darkening to the dorsal upper-orbital. From *allecta*, *flavinotum* may be distinguished by the broad yellow margin of the mesonotum extending above the wing bases and onto the mesonotum to the fourth dorsocentral, placing the inner postalar on yellow.

Puparia lent by Dr. Frost from blotch mines in *Eupatorium purpureum* at Ithaca, New York, have elongate anal lobes similar to those of *majuscula* (fig. 3c). The larvae form large blotches on the leaves and Frost (1924, Plate II, fig. 2) illustrates such a mine. Apparently there are several mines per leaf that coalesce as the larvae grow.

11. **Phytobia (Calycomyza) allecta** (Melander)

Agromyza lateralis Williston, 1896 (*nec* Macquart, 1835), Trans. Ent. Soc. London, 1896: 428, fig. 156. Primary homonym.

Agromyza allecta Melander, 1913 (n. n. for *A. lateralis* Williston, 1896, *nec* Macquart, 1835), Jour. New York Ent. Soc., 21: 257; Frost p. p., 1924, Cornell Univ. Agric. Exp. Sta. Mem., 78: 38.

Phytobia (Calycomyza) allecta (Melander), Frick, 1952, Univ. Calif. Publ. Ent., 8: 394.

Female: Head (profile): eye 1.5 (1.4–1.75) times as high as long; gena 0.13 (0.12–0.25) of the eye height; genovertical plates hardly extending anteriorly of eyes; third antennal segment ovoid, longer than wide (fig. 1c). Head (front view): genovertical plates yellow, sometimes dark from vertex to nearly halfway to dorsal upper-orbital; 2 (rarely 3 on one side) lower-orbitals on either side; mesofacial plate yellow. Mesonotum: subshining, presutural seta on black, at edge; supraalar on black, far removed from yellow; narrowly yellow above wing base; outer and inner postalar on black; fourth dorsocentral on black, far removed from yellow; humeral seta on yellow (rarely touching black), 12 (9–15) humeral setulae; 6 irregular rows of acrostichals between the dorsocentral rows; second dorsocentral 0.3 (0.3–0.6) of the third; inner postalar 0.5 (0.4–0.5) of the outer. Legs: mid-tibiae each with 2 or 3 posterolateral spurs; fore-femora distally yellow, narrow, for about one-half femoral diameter. Wings: margin and fringe of calypter black; r-m cross vein distal to, 1.2: 1 (1.0–2.3) center of cell 1–M_2; m-m cross vein about, 1.1: 1 (0.6–1.25), its own length from r-m, perpendicular (or at a slight angle) to penultimate section of M_{1+2}; ultimate section of M_{3+4} 1.7 (1.5–2.5) times as long as penultimate. Size: 2.5 (♂ = 2.25–2.5; ♀ = 2.25–2.6) mm. in wing length.

Lectotype ♀. St. Vincent, West Indies, deposited in the Snow Entomological Collections, University of Kansas, Lawrence, Kansas. There are two specimens of Williston's syntype series deposited in North American museums: the University of Kansas female and a headless, abdomenless specimen, No. 20,331, in the American Museum of Natural History, New York City. Four specimens from the syntype series in the British Museum were studied. They represent four species including *allecta*, *lantanae*, sp. undetermined, and a *Melanagromyza* sp. The choice of a lectotype was between two females, one in the British Museum and the one in the Snow Collection. Both conform closely to Fig. 156 of Williston's paper, particularly in the ovoid third antennal segment. However, neither has three lower-orbitals, but two is by far the most common number (91%) in this species. Therefore, I chose the University of Kansas specimen in order that the museum location of the type will be in the same geographical area as the range of the species in nature. The limits of variation in *allecta* were determined from 13 specimens from South Dakota, Kansas, Indiana, Pennsylvania, and Puerto Rico.

Frost (1924) included *Arctium-*, *Bidens-*, and *Eupatorium*-mining specimens in his concept of *allecta*. A study of all available specimens showed that adults reared from *Arctium lappa* and *Eupatorium purpureum* are of a different species (*flavinotum* n. sp.) from those mining *Bidens*, *Helianthus*, and *Rudbeckia* spp. I have therefore restricted *allecta* to the specimens with the following host records: Arendtsville, Pennsylvania, VII-24-1927 (S. W. Frost), *Helianthus* sp.; VIII-11-1922 (S. W. Frost), *Rudbeckia* sp.; VIII-26-1920 (S. W. Frost), *Bidens frondosa*. There are two teneral adults from Richmond, Indiana, and two puparia from Dayton, Ohio, all reared from *Rudbeckia* sp. I include these in *allecta*, although positive determination is difficult. With some reservations I refer two paratypes of *cassiae* Frost, 1936, to *allecta*. These two, 1♂, 1 ♀, La Caja, 8 kil. west of San Jose, Costa Rica (H. Schmidt), I could not distinguish from adults of *allecta*. However, the host plant (*Sauvia* sp., family Euphorbiaceae) leaves some doubt that these specimens are of the same species as those mining composites.

I have studied unreared specimens from Colorado, Texas, Kansas, South Dakota, Wisconsin, Michigan, Illinois, Indiana, New York, New Jersey, and Maryland in the United States and Saskatchewan, Manitoba, and Ontario in Canada. *P. allecta* has been collected from the islands of St. Vincent, Hayti, and Puerto Rico in the West Indies.

P. allecta is easily separated from the similar-appearing *flavinotum* by having the inner postalar on black, the supraalar far removed from the yellow of the lateral margins of the mesonotum. Superficially *allecta* and *artemisiae* are similar. However, the black of the vertex does not reach the dorsal upper-orbital, as it does in *artemisiae*, the third antennal segment is ovoid, and the mesofacial plate is yellow.

Frost (1924) described the larvae. However, as pointed out previously he had larvae of both *allecta* and *flavinotum*. The larvae of both bear elongate anal lobes similar to those of *majuscula* and *artemisiae* (figs. 2c, e, and 3c).

12. **Phytobia (Calycomyza) malvae** (Burgess), new combination

Oscinis malvae Burgess, 1880, U. S. Dept. Agric. Ann. Rept., 1879: 202.

Agromyza jucunda (van der Wulp), Coquillett *p. p.*, 1898, U. S. Dept. Agric. Div. Ent. Bull. 10: 77.

Agromyza cassiae Frost p. p., 1936, Ann. Ent. Soc. Amer., 29: 306.

Female: Head (profile): eye 1.6 (1.4–1.7) times as high as long; gena 0.2 (0.13–0.2) of the eye height; genovertical plates not extending anteriorly of eyes; third antennal segment round. Head (front view); genovertical plates dark to

ventral upper-orbital, 2 (rarely 3) lower-orbitals on either side; mesofacial plate yellow, not more than antennal bases dark. Mesonotum: subshining; humeral seta on black, 6 (6–8) humeral setulae; 6 irregular rows of acrostichals between the dorsocentral rows; second dorsocentral 0.4 (0.3–0.4) the length of the third; inner postalar 0.4 (0.4–0.5) the length of the outer. Legs: mid-tibiae each with 3 (sometimes 2) posterolateral spurs. Wings: margin and fringe of calypter black; r-m cross vein distal of, 2.25: 1 (1.2–2.5), center of cell 1-M_2; m-m cross vein less then, 0.7: (0.7–0.9), its own length from r-m, perpendicular (rarely at a slight angle) to penultimate section of M_{1+2}; ultimate section of M_{3+4} 2.0 (2.0–2.7) times as long as penultimate. Size: 1.75 (♂ = 1.75–1.8; ♀ = 1.8–2.0) mm. in wing length.

Female: Similar to male; gena 0.13 of the eye height; humeri with 8 setulae each; second dorsocentral 0.4 as long as the third; r-m cross vein distal of (1.5: 1) center of cell 1-M_2; mm. about (0.9: 1) its own length from r-m, at a slight angle to penultimate section of M_{1+2}; ultimate section of M_{3+4} 2.3 times as long as the penultimate; 1.8 mm. in wing length.

Lectotype ♀. Washington, D. C., XI-14-1879 (T. Pergande), "Leaf miner on *Malva rotundifolia*" (Coquillett, 1898). There are two females and a puparium on the pin bearing the label: "Type No. 19,127, U. S. N. M." I have designated the female on the edge away from the puparium as the lectotype. All three specimens are in the United States National Museum, Washington, D. C.

P. malvae has been reared from the following host plants: 1♂, Lafayette, Indiana, XI-15-1913 (J. M. Aldrich), ex *Malva rotundifolia;* 3♂♂, 3 ♀♀, Lafayette, Indiana, X-17 and 18-? (J. M. Aldrich), ex *Malva rotundifolia;* 1♂, 1 ♀, Lafayette, Indiana, no date (J. M. Aldrich), ex *Abutilon theophrasti;* 2♂♂, 4 ♀♀, Lafayette, Indiana, VIII-2, XI-6, and XI-16-1913 (J. M. Aldrich), ex hollyhock (*Althaea* sp.); 1, State College, Pennsylvania, VII-18 and 20-1953 (S. W. Frost), "Linear mine hollyhock;" 2, Lafayette, Indiana, X-18-1915 (Satterthwait), ex *Sida spinosa;* 4 (as paratypes of *cassiae* Frost, 1936), Ancon, Panama Canal Zone, II-2-1929 (S. W. Frost), ex *Malvastrum coromandelianum.* I have identified unreared specimens of *malvae* from California, Arizona, New Mexico, New York, and Florida.

The adults of *malvae* are rather easily distinguished by the yellow mesofacial plate and the genovertical plates darkened to the ventral upper-orbital. *P. majuscula, gigantea,* and *cynoglossi* also have the genovertical plates darkened at least to the ventral upper-orbital, but have the mesofacial plate at least two-thirds dark.

The puparia have three spiracular bulbs on the posterior spiracles, the ventral one being about twice the length of the other two. Burgess gave a good description of the mines and a general description of the larvae.

13. **Phytobia (Calycomyza) ambrosiae,** new species

Agromyza platyptera var. *jucunda* (van der Wulp), Frost *p. p.*, 1924, Cornell Univ. Agric. Exp. Sta. Mem., 78: 50.

Male: Head (profile): eye 0.5 (0.5–0.7) times as high as long; gena 0.18 (0.17–0.20) the eye height; genovertical plates extending slightly anteriorly of eyes dorsad of antennae; third antennal segment rounded. Head (front view): genovertical plates dark from vertex to dorsal upper-orbital; 2 lower-orbitals on either side; frontal vitta 1.25 (1.25–1.4) times as high as wide; mesofacial plate yellow. Mesonotum: subshining; humeral seta on yellow, 6 (6–8) humeral setulae; 6 irregular rows of acrostichals between the dorsocentral rows; second dorsocentral seta 0.36 (0.36–0.44) the length of the third; inner postalar 0.4 (0.35–0.4) the length of the outer. Legs: mid-tibiae each with 1 (or 2) posterolateral spurs. Wings: margin and fringe of calypter black; r-m cross vein distal to, 1.2: 1 (1.2–1.8), center of cell 1-M_2; m-m cross vein at its own length from r-m, at a very slight angle (sometimes perpendicular) to the penultimate section of M_{1+2}; ultimate section of M_{3+4} 2.5 (2.0–2.5) times as long as penultimate. Size: 1.75 (♂ = 1.5–1.8; ♀ = 1.75–2.0) mm. in wing length.

Female: Very similar to male; frontal vitta 1.3 times as high as wide; mid-tibiae each with 2 posterolateral spurs; ultimate section of M_{3+4} 2.0 times as long as penultimate; size, 2.0 mm. in wing length.

Holotype ♂. Nashville, Tennessee, no date (G. G. Ainslie), "Reared from *Ambrosia artemisiifolia,*" deposited in the United States National Museum, Washington, D. C. *Allotype* ♀. Topotypical, same data as holotype. *Paratypes.* 1 ♀, topotypical, same data as holotype; 2 ♂♂, 1 ♀, Lafayette, Indiana, VIII-14, 19, and 21-? (J. M. Aldrich), "Leaf-miner in *Ambrosia trifida;*" 1♂, Royal Palm, Florida, VII-22-1948 (L. D. Beamer).

The three specimens from Lafayette are slightly teneral and have the heads partially collapsed. There is one denuded, headless specimen that I am referring to this species as it bears the same data as the holotype. S. W. Frost has two females in his collection labelled: Arendtsville, Pennsylvania, VIII-12 and 29-1927 (S. W. Frost), ex *Ambrosia artemisiifolia* and *A. trifida.*

P. ambrosiae is most similar to *verbenae* but may be separated by the relatively wide frontal vitta, it being not more than 1.4 times as high as wide. In *verbenae* the frontal vitta is not less than 1.7 times as high as wide. Also, the inner postalar is up to 0.4 times as long as the outer in *ambrosiae* while in *verbenae* it varies from 0.4 to one-half as long. *P. artemisiae,* similar in having the genovertical plates dark to the dorsal upper-orbital,

may be distinguished by the mesofacial plate being about one-half dark.

14. **Phytobia (Calycomyza) verbenae** (Hering)

Agromyza jucunda (van der Wulp), Coquillett *p. p.*, 1898, U. S. Dept. Agric., Div. Ent. Bull. 10: 77.
Dizygomyza (Calycomyza) verbenae Hering, 1951, Not. Ent., 31: 42.
Phytobia (Calycomyza) verbenae (Hering), Frick, 1953, Canad. Ent., 85: 70.

Adult (22 specimens): Head (profile): eye 1.6 (1.4–1.7) times as high as long; gena 0.2 (0.15–0.20) of the eye height; genovertical plates slightly extending anteriorly of eyes; third antennal segment round. Head (front view): genovertical plates dark to dorsal upper-orbital; 2 lower-orbitals on either side; frontal vitta 1.8 (1.7–2.0) times as high as wide; mesofacial plate yellow. Mesonotum: subshining; humeral seta on yellow, usually touching black, 8 (7–11) humeral setulae; 6 irregular rows of acrostichals between the dorsocentral rows; second dorsocentral 0.4 (0.3–0.5) the length of the third; inner postalar 0.4 (0.4–0.5) the length of the outer. Legs: mid-tibiae each with 2 or 3 posterolateral spurs; fore-femora distally yellow for a distance equal to about one-half the femoral diameter. Wings: margin and fringe of calypter black; r-m cross vein distal to, 1.7: 1 (1.2–1.8), center of cell 1–M_2; m-m cross vein about, 0.9: 1 (0.7–1.0), its own length from r-m, perpendicular to the penultimate section of M_{1+2}; ultimate section of M_{3+4} 2.4 (2.0-2.8) times as long as the penultimate. Size: 1.75–2.0 mm. in wing length.

Holotype ♀: State College, near Las Cruces, New Mexico, VII–7 to 10–1949 (J. R. Eyer), ex *Verbena hybrida*, cultivated var., deposited in the United States National Museum, Washington, D. C. *Paratypes*. 3♂♂, 2 ♀♀, same data as the holotype, none deposited in the U. S. National Museum. R. H. Foote greatly helped this study by comparing four specimens with Hering's holotype about one year before I was in a position to visit the National Museum.

The species was first collected from cultivated verbena in 1874 (Coquillett, 1898). These specimens are in the National Museum and are true *verbenae*. Coquillett confused them with *jucunda* and since that time they have been placed under that name.

I have studied 56 specimens, 22 of which were reared from *Verbena* spp. It is these 22 that were used in the description to determine the limits of variation. *P. verbenae* appears to be relatively common now that its true identity has been made known. There are specimens from Arizona, New Mexico, Texas, Missouri, Illinois, Indiana, Ohio, New York, Pennsylvania, New Jersey, Washington, D. C., Maryland, Georgia, Florida, and Mississippi.

P. verbenae is most similar to *ambrosiae* but *ambrosiae* has a moderately wide frontal vitta, it being not more than 1.4 times as high as wide. The inner postalar is up to 0.4 as long as the outer in *ambrosiae* while it varies from 0.4 to 0.5 as long as the outer in *verbenae*. *P. verbenae* is quite similar to *artemisiae*, but can be separated by the narrow frontal vitta and the yellow mesofacial plate. The frontal vitta is 1.7 times as high as wide while in *artemisiae* it is about as high as wide.

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NOTICE TO MEMBERS

See Program Highlights on page 5 of the June 1956 BULLETIN OF THE ENTOMOLOGICAL SOCIETY OF AMERICA. The deadline for receipt of titles and abstracts of papers to be presented at the Annual Meeting in New York in December is September 1, 1956. Send to P. W. Oman, Chairman of the Program Committee, Entomology Research Branch, Beltsville, Md.

OBITUARIES

Alfred F. Satterthwait

1879–1954

Alfred Fellenberg Satterthwait (1879–1954), American naturalist and writer and for 47 years a member of our Society, was born in Fairville, Chester County, Penn., April 9, 1879. He was the son of George T. and Sarah (Conard) Satterthwait. He was reared on a farm, was educated in Pennsylvania public schools and in West-town Friends' Boarding School, was graduated 1897. Also, he had a Jessup scholarship at the Academy of Natural Sciences, Philadelphia, 1898–1900. He was agriculturist in Penn-

sylvania, 1901–1904; assistant in zoology in Division of Zoology, Pennsylvania State Department of Agriculture, 1905–1910; solicitor Provident Life and Trust Company, Philadelphia, 1910–1913. He entered U. S. Government Service April 28, 1913 in the Department of Agriculture, Bureau of Entomology; became specialist in life history and control of cereal and forage insect pests under the leadership of the late Prof. Francis Marion Webster; served in Indiana 1913–1916, in Charleston, Missouri 1916–1918; was in charge of Field Laboratory at Webster Groves-Kirkwood, Missouri, 1918–1936; transferred to Urbana, Illinois Field Laboratory, July 1, 1936. He retired from the public service April 1, 1948 and removed shortly thereafter to St. Petersburg, Florida, where he died September 22, 1954. He is survived by his wife Elizabeth Allen Satterthwait (with whom he was united in marriage on June 22, 1911.) and by a sister Mrs. Helen Matteson of Turtle Creek Pennsylvania.

In addition to his official assignments in cereal and forage insect investigations, he also specialized in life history, ecology and control of the coleopterous genus *Calendra* and its parasites. He also did extensive work on the lepidopterous genus *Heliothis*. For one having done much work in entomology, his output of published writings may appear relatively small. Though comparatively few in number, they rank in quality among the more important contributions which have appeared in their respective subjects. Between 1916 and 1933, his economic papers were on various species of aphids and cutworms, and on true army worm and chinchbug, whereas his ecological and systematic publications reported on results of his studies of *Calendra pertinax* Oliv., and related species. Deeply interested in the literature of entomology and related subjects, birds, plants, etc., he built up over the years an exceptionally useful and increasingly valuable library, that was especially strong in rare periodical sets and separates in Coleoptera.

He was a member of the Religious Society of Friends, and his memberships and fellowships in various scientific and other organizations included the following, in addition to that in our own Society: American Association for the Advancement of Science; American Nature Study Society; New York Entomological Society; Harrisburg (Penn.) Nature Study Society, (past sec'y); St. Louis (Mo.,) Academy of Science, (past president); Webster Groves (Mo.,) Nature Study Society, (past president); and St. Petersburg (Florida) Audubon Society, (past president).

A man of high ideals, strong in convictions, sound in judgment, a tireless energetic worker, an excellent observer, he put a rare enthusiasm into every detail of his scientific work—even into the accuracy and arrangement of his meticulously kept records, and their ready availability to other research workers. One of his outstanding characteristics was his deep and sympathetic interest in the needs, problems, welfare and advancement of other younger workers in entomology, particularly those who were so fortunate as to be for a while under his inspiration and leadership. It gave him deep satisfaction later on to live to see a number of these with the passing of years go out and perform valuable work and attain positions of responsibility and leadership and honor in various fields of research and scholarship. His pleasing wholesome personality, his genuine friendliness to every one, and his always thoughtful courteous consideration for others, won for him wherever he went a wide circle of enduring friendships. There are many of us to mourn his departure, and we realize not only our own loss, but that in his passing there also has been a very definite loss to American Entomology.

J. S. Wade

Zeno Payne Metcalf

1885–1956

Dr. Zeno Payne Metcalf died at his home at Raleigh, N. C., January 5, 1956. Even though he had suffered poor health for many months, he died quite suddenly and unexpectedly while talking to his wife and daughter, Mrs. Micou Brown of Raleigh.

Dr. Metcalf was a tireless worker and continued pushing himself to the utmost to the very last, as he was in his office working on the catalog of the Homoptera of the World until noon of the day he passed away. He devoted his whole professional life to State College and brought international repute to the institution.

On March 11, 1955, Dr. Metcalf was presented the Oliver Max Gardner Award as "That member of the faculty of the Consolidated University of North Carolina who during the current scholastic year has made the greatest contribution to the human race."

Dr. Metcalf was the author of nine books and an active member of 36 learned and professional societies. He was a key speaker at the International Congress of Zoology which convened in Paris in July, 1948, and at the International Congress of Entomologists which met in Stockholm in August, 1948. In addition he was past-president of three major national scientific organizations, The Entomological Society of America, The Ecological Society of America and the American Microscopical Society—a distinction accorded few scientists in the United States.

Dr. Metcalf also served on the editorial Boards of four of the large national professional journals and was the author of 96 professional publications. At the time of his death he was engaged in preparing a 42-volume catalog of the Homoptera of the World. Fifteen volumes had been or were in press at the time of his death, and several more volumes are nearly ready to go to press. An attempt is being made to provide means of completing the entire set. Dr. Metcalf has spent much of the past 40 years collecting notes for the series. In an effort to obtain material he read and checked over 20,000 books and papers dealing with insects and visited all the principal libraries in the United States and England. The order Homoptera comprises about 4,000 described genera and 30,000 described species. The catalog now contains 512,000 references, probably the greatest catalog of any order of insects to be found anywhere in the world.

A native of Lakeville, Ohio, Dr. Metcalf was educated at Ohio State University where he received his A.B. degree in 1908 and at Harvard University where he earned his D.Sc. degree in 1924.

Prior to joining the State College Faculty in 1912 he was an Instructor in Entomology at Michigan State, 1907–1908 and was on the staff of the North Carolina State Department of Agriculture 1908–1912. He joined the North Carolina State College Faculty as Entomologist with the Experiment Station and as Professor of Zoology and Entomology. He was Visiting Professor in the summer session of Ohio State in 1916 and 1918 and in the summer session of the University of Michigan in 1926. During the school year of 1935–36 he served as Visiting Professor of Zoology at Duke University. Dr. Metcalf was Head of the Department of Zoology and Entomology, North Carolina State College, from 1912–1950. He was Director of Instruction in the School of Agriculture at North Carolina State College during the years, 1923–1944; Director of Graduate Studies at the College, 1940–1943, and Associate Dean of the Graduate School of the Consolidated University, 1943–1950. He retired from administrative duties in 1950 and later devoted his full time to teaching, research and writing. In his latter years of teaching he was the William Neal Reynolds Professor of Zoology and Entomology.

He was active in both civic and professional affairs and was a former President of the N. C. Academy of Science and a past-President of the Raleigh Kiwanis Club. He was also a Fellow of the American Association for the Advancement of Science and the Entomological Society of America.

Dr. Metcalf was married to Miss Mary Luella Correll of Wooster, Ohio, on October 20, 1909. He is survived by his wife and by his daughter, Mrs. Katherine Brown.

CLYDE F. SMITH.

BOOK NOTICES

THE PHYSIOLOGY OF DIAPAUSE IN ARTHROPODS, by A. D. Lees. Pp. 151, 24 figs., Cambridge Monographs in Experimental Biology, No. 4. Cambridge University Press. 1955. $2.50.

Here is another fine addition to this new series of pocket-size monographs. The large percentage of recent titles in the bibliography indicates the activity of study on this subject at present. Considering the small size of the volume an amazing amount of detail is given about each of the many cases cited. Chapter titles include environmental effects on both onset and termination, inheritance, the role of water, metabolic and humoral aspects, and phenology.

Formerly it appeared easy to define diapause but, as has happened with so many terms, enough diverse cases are now known to render any simple definition uncertain if not indeed fuzzy. Embryonic processes are commonly divided into growth, differentiation and maintenance. It has been thought that diapause represented a cessation of growth and differentiation with only maintenance being active. It now seems certain that there is no true cessation but rather a specific "diapause development" which is essential to further development. Why this should be true is still unknown but it seems most readily imagined as necessitated by some balance of phenomena, perhaps competition between processes with widely differing temperature coefficients.

It has long been known that in nature temperature affects the duration of diapause. A more recent discovery is that photoperiods are also determinative. Seasonal timing of emergence is controlled by these two factors which operate through endocrines of the larvae and pupae in some cases, through the mother's endocrines for eggs, through changes in water content in some, and apparently by other means in certain cases.

Scientists in general prefer minimum explanations but it seems clear that enough data have now accumulated to make any one-point explanation of diapause less than unlikely. No one answer is adequate. For instance, data are consistent with the idea that diapause in *Melanoplus differentialis* is controlled by water content but that this cannot be the control for *Melanoplus bivittatus*. Presumably we are dealing with sets or catenary chains of reactions where the same end result (diapause) may be obtained by stoppage of any of several steps. In non-diapausing species no such stoppage is necessary, and in at least some it seems that maintenance is not possible without simultaneous growth. This little book seems to me most instructive in showing the futility of seeking one-point answers to complex biological phenomena.

The book is simply and clearly written. It is intended not just for physiologists but also for ecologists and field entomologists in general. It could well be listed as required reading for all entomologists.

A. Glenn Richards.

THE NATURAL HISTORY OF TSETSE FLIES, by Patrick A. Buxton. London School of Hygiene and Tropical Medicine, Mem. 10. Pp. xx + 816, 165 text figs., 47 plates. 1955. Price, £ 4. 4s. 9d.

Tsetse flies are of interest to the entomologist not only because of their medical and veterinary importance, but also because of their very interesting biologies and because of the contributions which taxonomic studies of this group have made to the theory and practice of systematics. The literature on these insects is extensive, but no previous work has assumed the magnitude of the present monograph nor has been able, because of the limitations in our knowledge, to make as broad generalizations. The plan and execution of the present volume is, therefore, well justified by the needs.

The approach is strongly ecological. The author used due caution, however, in attempting to make correlations between climatic factors and tsetse biology and distribution, since (1) our quantitative knowledge of wild populations is in general inadequate; (2) the subject of climatic factors is so complex; and (3) it is difficult to distinguish the effects of climate directly on the tsetse from those on the vegetation which, indirectly, affects the insect. Indeed, the caution which the author exercises in his statements, together with the thorough documentation, makes one have more faith in his statements of a positive nature. This statement does not imply any indecision, but merely that the author, in truly scientific fashion, is not willing to generalize on insecure grounds. The two chapters entitled "Tsetse and Climate" and "Tsetse and Vegetation" (100 pages) contain the fundamental aspects of the ecological material, although one is well aware of the ecological approach throughout most of the text.

The systematic aspects are dealt with chiefly in chapter 1 (pp. 1–34), which includes a technical key to the species, together with three simpler, less technical keys for the recognition of species occurring in particular regions. The problem of species, subspecies, and races is also discussed here. Much anatomical material on the adult and larva is brought in elsewhere, however; for example, the extensive discussion of the mouthparts in Chapter 3 is noteworthy. Chapter 11 contains a partial key to puparia. The problem of tsetse systematics is dealt with, also, in other places in the book, for example, in the chapter (10) on reproduction, where cross-pairing and hybridation are discussed. Significantly, the author cites Vanderplank's suggestion that *Glossina newsteadi* may have arisen as a hybrid species. Larval and pupal anatomy are discussed extensively. In the chapter on geographic distribution, the author shows that there is a close correlation between tsetse distribution, taken as a whole, and annual rainfall, under tropical conditions, of 30 inches or more; he also gives reasons for accepting the single record of extant tsetse flies outside Africa (*viz.*, Arabia), a record that has been widely considered suspect.

The subject matter of other parts of the book is indicated by chapter headings: Feeding, Digestion, and Excretion; Metabolism; Sense Organs; Discovery of Host; Sources of Food; Movement and Rest; Causes of Death; Populations of Tsetse; Control of Tsetse; Tsetse and Trypanosomes; Tsetse in Relation to Disease. The physiological chapters are of interest *per se* and in respect to other phases of tsetse biology; for example, the impact of the physiology of digestion and feeding on the reproductive biology of a fly that must, if a female, carry within her body and nourish a maggot until it is practically ready to pupate and, consequently, as heavy as the mother would be after the birth of the maggot! The chapter on "Causes of Death" includes an extensive discussion of natural enemies and diseases. Control, naturally, relies strongly on the utilization of ecological information and methods. The inclusion of the chapters on trypanosomes and trypanosomiases is novel and, as the author points out, a step which would not have been considered proper territory for such a work a few years ago.

An appendix (pp. 705–739) deals largely with methodology both in field and laboratory studies. The 27 pages of references bring the literature up to 1952 but do not aim at bibliographic completeness, many references, particularly the less important earlier ones, being

omitted intentionally. The index seems adequate. The plates, grouped at the end of the book, are mostly photographic and deal mainly with the haunts, habitats, and breeding areas and with modifications of the above in relation to control measures.

The tsetse is, truly, a remarkable animal, and Dr. Buxton has done justice to it in his lucid, interesting, well-planned, well-documented, ably-illustrated monograph. It is a pleasure to review such a book.

MAURICE T. JAMES.

A CENTURY OF PROGRESS IN THE NATURAL SCIENCES, 1853–1953. Edited by EDWARD L. KESSEL. Paper bound. 1955. California Academy of Sciences, San Francisco. x + 807 pp., illus. $10.50.

This substantial volume celebrating the centennial of the California Academy of Sciences is a group of 40 essays on the central theme "the historical treatment of biosystematics," contributed by 37 writers. In addition to essays on systematic entomology, there are readable, enlightening summaries on such topics as botany (8 essays), San Francisco as a Mecca for 19th century naturalists, natural history and human progress, herpetology, ornithology, mammalogy, paleontology, animal geography, and wildlife conservation. Accomplishments made during the years 1853–1953 are emphasized, and it is significant that two trends mentioned again and again are the improvements in approach and understanding, in relation to biosystematics, which resulted first from the doctrine of evolution, and secondly from the recent, growing appreciation for the "new systematics." This book enables a student to see something of the history of the study of various plant and animal groups, and to read of the helpful or retarding influences of past trends, and of the type of work which, in the opinion of the various reviewers, has been most appreciated decades later. Many reviewers give glimpses of the colorful personal lives of past workers, and the personal touches often will hold the interest of readers. Much of the discussion is from a world-wide point of view, though some treatments are for North America only. The stimulating influence of the California Academy of Sciences frequently merits attention. The book has no general index, but many articles have bibliographies and nearly all have abundant citations of published work, by author and year. There is a roster of naturalists (mostly past ones) associated with the San Francisco Bay region (pp. 39–63).

The section on entomology comprises a total of 105 pages, contributed by 22 entomologists, all North Americans except Per Brinck and J. V. Pearman. It is under the general editorship of Edward S. Ross, who has written a thoughtful historical sketch and an appraisal of future needs, the latter containing a plea for the amateur—or at least the enthusiasm and other desirable qualities of amateurs. Dr. Ross also has written the short essay on Embioptera, one of several brief discussions of minor orders.

Fine historical reviews, replete with comments on outstanding systematic workers who have shaped their science, also with hopeful suggestions for the future, are by W. T. M. Forbes, M. H. Hatch, and C. P. Alexander, respectively, for the Lepidoptera, Coleoptera, and Diptera. Z. P. Metcalf treats the auchenorhynchous Homoptera and shows the value of zoogeographic studies. G. F. Ferris summarizes developments on the Coccoidea, Anoplura, and Mallophaga, and by emphasizing the importance of making slide mounts of small insects or parts of large insects he stresses his belief that a knowledge of proper methods is the key to real progress. R. L. Usinger reviews the Hemiptera and notes the need for broad phylogenetic study and for comprehensive synthetic work bringing together the loose ends. Mrs. Leonora K. Gloyd treats the Odonata and states that one reason for a tremendous growth of knowledge about that group in the century just past is "the strong friendships and cooperation among the leaders who have unselfishly shared their knowledge with all who sought it."

C. L. Remington reviews the "Apterygota" and in addition to an historical summary he introduces some new ideas on classification, as a result of which he recommends the broadening of our concept of insects to include not only Collembola and Protura, but also groups such as centipedes and millipedes. This opinion could be the basis for considerable critical discussion by morphologists and students of phylogeny. Space does not permit me to mention all the essays on entomology. A few groups have not been reviewed; the omissions noted are termites, earwigs, sawflies and parasitic wasps, aphids, Orthoptera, and arachnids.

The reviews of systematic entomology can give an entomologist pride in what has been done, for the most part, and they should give an improved perspective for the future. As the decades pass, we shall have an increased need for reasonably brief summaries like these on our own and other groups if we are to have sound foundations and breadth of view.

ASHLEY B. GURNEY

THE SARDINIAN PROJECT: AN EXPERIMENT IN THE ERADICATION OF AN INDIGENOUS MALARIOUS VECTOR. By JOHN A. LOGAN WITH THE COLLABORATION OF T. H. G. AITKEN, G. U. CASINI, F. W. KNIPE, J. MAIER, A. J. PATTERSON. Baltimore, The Johns Hopkins Press, 1953 (The American Journal of Hygiene Monographic Series No. 20). $7.50.

This volume presents a report on the first concerted large-scale effort to eradicate an indigenous malaria vector in a large isolated area. Despite the expenditure of vast amounts of money (over $12,000,000) over a period of 5 years (1946–1951), the utilization of over 30,000 workers at the peak of the program, and the guidance of experienced personnel, chiefly drawn from the Rockefeller Foundation, *Anopheles labranchiae* was not eradicated from Sardinia (area: 9250 sq. miles). However, much valuable information and experience was obtained in eradication techniques and organizational and management problems which should prove to be very useful in any similar future attempts at eradication. The greater part of the volume is devoted to organizational, management and operational phases of the problem, with chapters on: The Background (22 p.); The Campaign (40 p.); Residual SprayingOperations (19 p.); Antilarval Operations (57 p.); Scouting and Entomological Service (35 p.); The Epidemiology of Malaria (39 p.); The Administrative Services (34 p.); Quarantine Service (12 p.); Housefly Control (18 p.); Critical Review (24 p.). The material presented in these chapters should be of great interest and value to everyone engaged not only in mosquito control but in all phases of insect control. To the biologist, the first two appendices are of greatest interest. T. H. G. Aitken summarizes the information obtained on the ecology of indigenous anophelines in the first appendix on The Anopheline Fauna of Sardinia (50 p.) and Harold Trapido discusses Biological Considerations in the second appendix (22 p.). Additional appendices are presented on the ERLAAS decree, Original Cost Estimate, Personnel, Insecticide Mixing Plant; and Recommendations to the Italian Government. A bibliography and index complete the book. The volume is copiously illustrated with 37 text figures, 51 tables and graphs, a map of Sardinia, 76 beautifully reproduced photographs and a colored frontispiece of *Anopheles labranchiae*.

The controversy over the feasibility of eradicating an indigenous malaria vector was not resolved by the Sardinia Project. However, before any similar project is undertaken, it would be well to consider the conclusions reached in this report: "From the evidence

furnished by ERLAAS, the eradication of an indigenous anopheline, such as *labranchiae*, is a difficult and expensive proposition . . . The use of eradication may, nevertheless, offer some advantages under certain special conditions, particularly when it is incorporated in a general conservation and development program, where part of the eradication could be charged to rehabilitation . . . [it] may have a limited field of use against other insects in both medical and agricultural fields, and it remains, therefore, as a potent though expensive possibility in any situation where man is engaged in raising living standards by the suppression or elimination of harmful insects. Eradication should be based on an accurate knowledge of the biology of the vector involved and provision should be made to utilize any equipment or method which seems advisable under the circumstances. The project should not be confined by time, finance or methods."—JOHN N. BELKIN.

KEYS TO THE GENERA OF MIRIDAE OF THE WORLD (HEMIPTERA), by José C. M. CARVALHO. Bol. Mus. Paraense Emilio Goeldi, Tomo XI, Fasc. 1, pp. 1–151, 16 plates (263 figs.) 1955. Caixa Postal 399; Belém, Para; Brazil.

Next to a reasonably complete and adequately curated collection, the most useful tool in the taxonomist's trade is a key that will readily distinguish species. The day when such keys are available for all major groups will mark the advent of the millenium for insect taxonomists. At present keys are usually available for Orders down to the level of subfamilies, and at the bottom of the taxonomic hierarchy there are many excellent keys to species of genera. On a regional basis keys are sometimes available for all levels. The great hiatus in most groups, and certainly in the Heteroptera, are keys to genera of families on a World basis. Dr. Carvalho has provided Hemipterists with such a key. In terms of species, the Miridae is the largest family of the Heteroptera. Economically it is also one of the most important. The 621 genera treated show the magnitude of the task.

In this paper, only genera that Carvalho recognizes as valid are included. Each genus is accompanied by the describer's name, year of publication and an indication of its distribution. The 263 figures adequately illustrate the characters used to distinguish the genera and higher categories. The arrangement proceeds logically from a key to the subfamilies. Under each of the subfamilies is a key to tribes and then keys to the genera of each tribe. The major classification follows that published by Carvalho in 1952 (On a major classification of the Miridae—With keys to subfamilies and tribes and a catalogue of the World genera: An. Acad. Bras. Cienc. 24(1): 31–111). Those desiring a more complete discussion of relations, synonymy and information on type species of genera should consult that work.

The principle weakness of the keys to genera is one recognized and mentioned by the author, who notes that they are based mainly on the type species of the genera. This places a high premium on the judgment of the author as to the characters most likely to have generic significance. No doubt some species will fail to key out in their proper genus, but the author's thorough knowledge of the family on a world basis is assurance that these will be few. The relatively few typographical errors speak well of Dr. Carvalho's knowledge of English and the ability of Brazilian typesetters to handle a foreign language.

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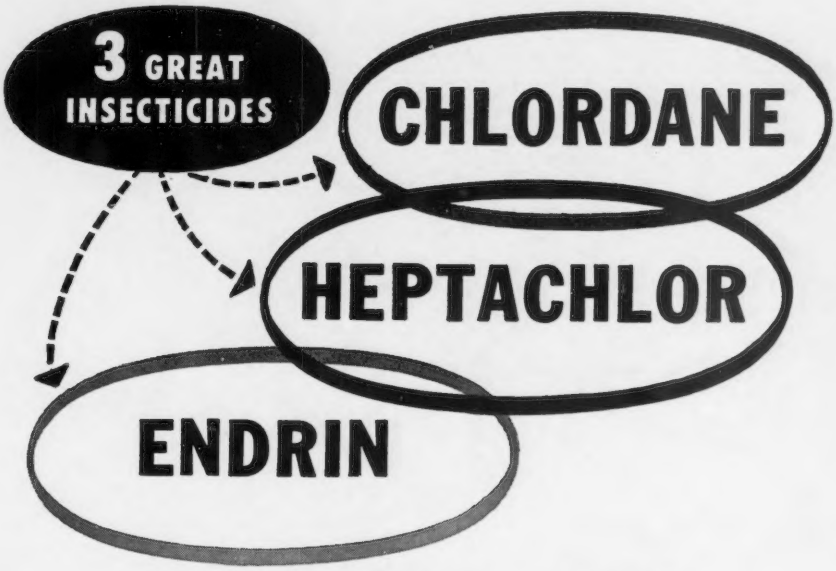

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